THE

ELECTRICAL REVIEW.

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J. A. BERLY'S

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For 1893

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THE LAMP SITUATION IN AMERICA.

AN important case has quite recently been decided in the United States Court of Appeal by Judges Wallace, Lacomb, and Shipman, the antagonistic parties being the Edison Electric Light Company and the Sawyer-Man Electric Company. The result is the victory of the first-mentioned combination. The Sawyer-Man Company, it will be remembered, was recently defeated in its endeavours to overthrow the Edison lamp patent, and in the present appeal it sought release from the injunction restraining it from manufacturing incandescent lamps. To properly understand the main points of contention, and also to appreciate the situation of electric lighting affairs generally in America at the present time, it will be well to briefly review the past history of the several parties who have undertaken the development of electric lighting across the Atlantic. In doing this, we can only refer to the leading organisations that have sprung into existence and played a *rôle* in the drama.

The list of companies who, amongst other things, manufactured incandescent lamps, started in 1880 with the Edison Electric Company and the United States Company. They were followed in 1883 by the Consolidated Electric Lighting Company, who managed to secure the Sawyer-Man lamp patents. Another organisation of great power was also born in 1883, viz., the Thomson-Houston Company. In 1886 these two last named companies negotiate together, and organise a lamp-making concern, called the Sawyer-Man Electric Light Company, the defendant in the suit under notice. Next, in 1887, the Sawyer-Man interests, including the share of the Thomson-Houston Company, are drafted over to the Consolidated Company; and in the year following the Thomson-Houston Company sells its stock in that company to the Westinghouse Company. The Thomson-Houston Company, however, retained certain privileges as regards the right to make and use lamps constructed under the Sawyer-Man patents, and also the power to make lamps under patents other than these. In addition to acquiring the Consolidated and the Sawyer-Man interests, the Westinghouse Company also absorbed the United States Company. Meanwhile, on the other side, the Edison General Electric Company was organised for the purpose of combining the Edison Company with various other corporations engaged in the manufacture and sale of electrical apparatus. Finally, last year, an understanding was arrived at between the ever-powerful Thomson-Houston Company—now practically severed from the Sawyer-Man interests—and the Edison General Company, and, as a result, a giant concern was brought out under the title of the General Electric Company. It will therefore be seen that, practically, the whole of the electric lighting industry in America is now concentrated in the General Electric Company and in the Westinghouse Company, although it should

be remarked that several of the affiliated concerns still preserve a certain amount of individuality in conducting their own business affairs.

With this general insight into American electrical companies' politics, we are in a position to follow the grounds on which the Sawyer-Man Company sought release from the injunction laid upon it, and, to this end, we cannot do better than quote the arguments from the ably-worded decision of the case :—

"1. Owing to the laches of the owners of the patent in asserting their claims, and in enforcing them, a large capital has been invested in the manufacture and sale not only of the lamps, but also in electric lighting apparatus, which will be greatly depreciated in value unless the lamps can be used with it, and that an injunction will cripple, and perhaps ruin, the local illuminating companies who have invested in the plants of the Westinghouse Companies, if they are prevented from using the lamp of the patent, and thereby subject to great inconvenience those whom these plants furnish with light, and displace a large number of persons who are employed in operating the plants.

"2. Because the complainants, and the other corporations with whom the complainants are associated, the competitors of the Westinghouse Company in business of making and supplying electric power and lighting, have entered into an unlawful competition to stifle competition in that business, and an injunction will be used unconscionably to further the objects of the combination; and

"3. Because, by reason of the affiliation of the Thomson-Houston Company with that combination, and the prior dealings of that company with the defendant, the Consolidated Company and the Westinghouse Company, an equitable estoppel has arisen, by force of which the complainants, as parties to the combination, ought not to be permitted to have an injunction."

On the first of these two points, the judges came to the conclusion that no undue delay had occurred in bringing on the case asserting the patent, and, as a consequence, no parties infringing the patent had reason to complain of their losses incurred in respect to accessory plant, no matter how great its value. And the same opinion was held in respect to all the users of infringing lamps and other requisite apparatus used in combination with them. As regards the second plea—that the combination under the name of the General Electric Company would fetter competition, and thus act as a restraint on trade—the judges were inclined to hesitate a little. The plaintiffs, they say, are clearly entitled to the injunction from the very nature of the patent law; but if, in carrying on their business, they should arbitrarily refuse to supply lamps to certain parties, or only do so at unreasonable prices, then will be the time to consider whether they should continue in possession of their injunction. On the third head the judges found that the alleged estoppel was far fetched and shadowy. The Thomson-Houston Company having separated itself from interest in the Sawyer-Man patents, was in no way bound to remain in allegiance with the Westinghouse Company.

It is now a little more apparent why the Westinghouse Company has been so alive to bringing out a new and non-infringing form of incandescent lamp. In view of the above decision its very existence in America would almost seem to hang on this new lamp during the interval in which the Edison lamp patent continues valid.

We have been inclined to imagine that civilisation has a tendency to decrease the amount of fighting between men. It is a question, however, whether the belligerent spirit is really less keen and rife now-a-days than it used to be. Perhaps after all we can only console ourselves with the reflection that its effect in this direction is only to diminish the amount of actual bloodshed.

A NEGLECTED SOURCE OF ECONOMY IN ELECTRIC POWER STATIONS.

WITH the opening of a New Year, those in whose hands lies the management of our manufacturing concerns, are prone to look around them, and while comparing the points of vantage gained during the past twelve months with those of previous years, scrutinise the directions in which it is probable still further economies may be effected. Electric supply is making that steady progress which was inaugurated about four years ago, and its universal adoption for purposes of lighting, and for distribution of power is now apparently a matter only of time and cost. As the present production of electricity is based mainly upon the transformation of mechanical into electrical power, it seems reasonable to expect that the greatest economy can be effected in the prime mover. In most of the large centres of population we are still dependent on the consumption of coal, and therefore any reduction in this must be a matter of vital importance from a financial point of view to both producers and consumers of electrical energy.

In this respect the position of electricity suppliers is analogous to that of steamship owners, and we find that these look very closely to their coal bills, the newest and most economical types of engines and boilers being used. Our electrical engineers would do well to take a leaf out of their book. But the successful running of a new type of engine is only accomplished by skilled and trained engineers, men who have undergone many years of hard practical work, and have gained their knowledge by that best of teachers, experience. It is to be feared that there are too many of the men responsible for the economics of central stations who have obtained their knowledge only from text-books and engineering colleges, which, whilst being admirable for supplementing practical training, can never give the self-reliance obtained by roughing it in the engineering world. Text-books usually deal with the machine as it should be, not as it is, besides neglecting the fact that mishaps will occur even to the most careful, and that the best man is he who, when such do occur, knows at once what to do and how to do it.

This knowledge can only be gained by long and varied experience. Many appointments are made through engineering schools which seek to impart the knowledge in a course of study extending over one or, at most, two years, which has taken other men perhaps ten, or more, to acquire. Engineers are responsible for all the important works carried out, and it is only by the employment of thoroughly competent men that we may hope for economy in production. Reserve plant is a considerable item in the first cost of installations, and it is self-evident that the more reliable are the men in

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LIST OF

ELECTRIC LIGHTING CENTRAL STATI

City town or district.	Name of company, if any.	Date of provisional order of license.	The period at which the lighting commenced.	System of lighting used and names of makers of dynamos.	Power used.	Engines and boilers and their horse-power.	Total number of arc lamps now in use, C.P. and cost per hour.	Total number of incandescent lamps now in use, C.P. and cost per hour.	Number of arc lamps and incandescent used in street lighting.	Number of lamps added during the past 12 months.	The present arrangement for carrying out the lighting.	Present capacity in lamps of generating station.	Description of mains.	Length of mains now laid.	Cost of t centre
ST. AUSTELL ..	Veale & Co., Ltd.	.. ..	March, 1886	Low tension	Steam	compound engines 170 H.P.	.. .. ..	.. ..	.. ..	.. ..	.. ..	1,500 16-C.P.	Underground	.. ..	..
BATH	City of Bath Electric Lighting Co.	June, 1891	June 24th, 1890	Thomson-Houston for street lighting, Brush alternating for private lighting	Steam	Babcock-Wilcox boilers, Raworth's engines 600 H.P.	10 1,200-C.P.	6,200 8-C.P.	84 arcs	2,200	Contract for seven years	10,000 incandescent, 200 arcs	Underground, Callender's solid system	40	£35,00
BIRMINGHAM ..	Birmingham Electric Supply Co., Ltd.	August, 1889	April, 1891	Low tension Crompton dynamos	Steam	Willans & Robinson steel Lancashire type	38 arcs, 1,500 C.P.	7,900 16-C.P.	.. ..	18 arcs, 2,700 16-C.P.	Provisional order ..	10,000 16-C.P., ultimate capacity 25,000 lamps	Underground, Crompton culvert with copper strip for feeders; Callender's solid system for distributing mains	6,960 yards	..
BRADFORD	Corporation	.. ..	.. ..	2-wire low tension Siemens dynamos and batteries	Steam	Willans engines Lancashire boilers	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	Underground Siemens armoured cable	.. ..	..
BRIDLINGTON ..	Local authority	.. ..	1890	Thomson-Houston arc lighter	..	Motive power hired from saw mill	18 arcs of 1,200 C.P.	.. ..	.. ..	.. ..	.. ..	.. ..	.. .. ..	½ mile	..
BRIGHTON	Corporation	1883	1891	2-wire low tension Goolden dynamos	Steam	Willans engines and Lancashire boilers	.. ..	Equal to 11,800 8-C.P.	.. ..	8,000	.. ..	8,000 8-C.P.	Underground armoured cables	4 miles	£41,00
,, ...	Brighton and Hove Electric Light Co.	.. ..	.. ..	Alternating current transformers	Steam	Fowler boilers and engines	.. ..	16,000 8-C.P.	.. ..	.. ..	.. ..	.. ..	Overhead insulated cables	14 miles	..
BUCKINGHAM ..	Buckingham Elec. Light Co. (private)	1889	1890	Low pressure and accumulators. Two Elwell-Parker dynamos	Steam and water	20 H.P. by water, 20 by steam	.. ..	3,004 16-C.P.	none	50	License	.. ..	Overhead	6 or 8 hundred yards	£1,200
CHAGFORD	G. H. Reed	.. ..	Sept. 1st, 1891	Alternating transformer (Hedgehog) Siemens Bros. dynamos	Water	.. .. ..	.. ..	300 8-C.P.	20 32-C.P.	.. ..	Contract	.. ..	Underground, lead covered paraffin paper insulation	1,800 yds.	£2,000
CHELMSFORD ..	Crompton & Co.	1890	May 14th, 1890	Alternating current and continuous arc lighting	Steam	Multi-Lancashire & Paxman boilers, Willans engines	19 10-ampères	1,500 private, 1,000 street, 8-C.P.	19 arcs, 250 32-C.P. in.,	1,000	Bd of Trade license	4,000	Overhead and underground	14 miles of street	£14,00
COWPEN QUAY and WATERLOO, BLYTH	Sanderson & Co.	.. ..	.. ..	Brush arc lamp in series	Steam	Babcock boiler, Chandler engine	19 2,000-C.P.	Only nine in station	19 arc lamps	.. ..	Contract for five years	25 lamps of 2,000 C.P.	Overhead fluid insulator	About 4 miles	£2,000
DUBLIN	Corporation	1890 and 1892	September, 1892	High tension alternating for incandescent direct for arc currents	Steam	3 compound engines of 350 H.P. 3 compound 751 H.P.	80 arcs of 1,200 C.P.	1,200 16-C.P.	80	.. ..	.. ..	10,000 8-C.P.	Underground vulcanised rubber in cast iron pipes	20 miles	£31,00
EASTBOURNE ..	Eastbourne Elec. Light Company	1891	Feb., 1892	Lowrie-Parker alternators and Lowrie-Hall transformers in parallel, transforming from 1800 to 100 in consumers' houses. Series circuit for arc lighting; Brush arc machines	Steam	Fowler & Co.'s engines and boilers, total engine H.P. 400	20 2,000-C.P.	7,000 8-C.P.	16 arc lamps	1,000	License	4,500 16-C.P.	Underground insulated cables drawn into cast iron pipes	9 miles	..
EXETER	Exeter Electric Light Co.	1891	September, 1889	High tension alternating (Mordey). High tension series arc (Thomson-Houston)	Steam	Two compound horizontal non-condensing 190 H.P., each by Fowler; and two Westinghouse triple expansion of 25 H.P.	35 of 1,200 C.P.	4,000 8-C.P.	None	1,300 8-C.P.	Provisional order	7,000 8-C.P.; 60 arcs	Fowler-Waring underground cable (concentric)	About 9 miles	£16,00
FAREHAM	Fareham Electric Light Co.	.. ..	September 1st, 1890	Thomson-Houston	Steam	Ransome, Sims and Co. com. engine	21 1,200-C.P.	92 20-C.P., 320 16 C.P.	20 arcs; 90 incand.	.. ..	Contract for three years	.. ..	Overhead and underground	16 miles	£5,000 (with
GALWAY	Galway Electric Co.	1890	June, 1889	Low tension. Crompton and Statter dynamos	Water Power	2 100-H.P. Hercules turbines, 12-foot fall	2 2,000-C.P. 1½d. per hour	940 8-C.P., 2 500-C.P., 3 200-C.P., 3d. per hour	Two arcs	150 8-C.P.	Provisional order	3,000 to 4,000 8-C.P.	Underground and overhead	4 miles	..
GLASGOW	Corporation	.. ..	.. ..	Low pressure 3-wire	..	Willans engines	.. .. ..	.. ..	..	.. ..	.. ..	12,000	Bare copper in culverts	.. ..	..
HALIFAX	Halifax Mutual Electric Light & Power Supply Co., Ltd.	None	January, 1889	Low tension, two wire, 110 volts. Blakey, Emmott & Co.'s dynamos	Steam	Two Lancashire boilers, 150 I.H.P. each	80 2,000-C.P. (10d.)	400 16-C.P.	None	100 16-C.P., 10 arcs.	.. ..	2,000 lamps of 8-C.P. At present fully loaded	Overhead wires	10 miles	..
HASTINGS	Hastings and St. Leonard's Electric Light Co.	.. ..	.. ..	Alternate current transformer. Mordey	Steam	Brush	.. ..	4,000 8-C.P.	..	.. ..	.. ..	.. ..	Underground	30 miles	..
KESWICK	Keswick Electric Light Co.	No Provisional order	Sept. 1st, 1889	Alternate current transformers (Kapp 30 unit made by Johnson and Phillips)	Water	Turbines (Victor) 63 H.P.	1 300-C.P. 1s. per hour	730 17-C.P.	..	.. ..	Contract	.. ..	Overhead on Johnson and Phillips fluid insulators	.. ..	..
LIVERPOOL	Liverpool Electric Supply Co.	1889, 1891, and 1892	1883	Direct current, 110 volts, Siemens and Crompton dynamos	Steam	Willans engines, Lancashire boilers 2,000 H.P. indicated	20 1,000-C.P. to 2,000 C.P. each	18,000 16-C.P.	None	2,000 16-C.P.	Provisional orders	37,000 16-C.P.	Underground Callender system.	50 miles	..
LONDON districts:															
BELGRAVIA and PIMLICO	Westminster Electric Supply Corporation	August 26, 1889	March 2nd 1891	Generation at 200, and distribution in two parallels of 100 volts each. Battery in parallel with 200-volt dynamo, Crompton and Siemens dynamos	Steam	Willans and Davey-Paxman engines, Davey-Paxman "Economic" boilers and Fraser of same kind. Total I.H.P. 760 (not yet condensing)	.. ..	Total three stations 98,820 8-C.P.	None	.. ..	Provisional order	30,800 8-C.P.	Underground copper in Kennedy type culverts. Insulated cable in Callender conduit	Total length of streets in which mains have been laid, 8·8 miles	..
CHELSEA parish and a portion of KENSINGTON parish.	Chelsea Electricity Supply Co., Ltd.	Sept. 1886, for Chelsea; Aug. 1889, for Kensington	September, 1889	Low pressure and secondary batteries (E.P.S.) in sub-stations with continuous current motor transformers, constant pressure at feeding points. Elwell-Parker dynamo	Steam	7 Willans & Robinson G. G. engines 80 I.H.P., two Willans & Robinson H. H. engines 125 I.H.P. Babcock and Mill's boilers	Two	35,000 8-C.P	None	8,000 8-C.P.	Provisional order	40,000 8-C.P.	Underground Callender - Webber bitumen concrete conduits and Callender's bitumen cable. Drawing-in system and feeding points	About 20 miles	..
ST. JAMES'S,	St. James's and	License,	April 4th,	Three-wire con-	Steam	Willans engines,	About 50 scattered	45,000 8-C P.	..	8,000 8-C.P.	Provisional	60,000 8-C.P.,	Underground bare	8 miles,	..

STATIONS IN GREAT BRITAIN.

n of	Length of mains now laid.	Cost of construction of central stations.	Percentage of the indicated engine power obtained at the terminals of the dynamo under conditions of normal work.	Coal consumption per hour for a unit, 1,000 watts delivered at dynamo terminals. Prices per ton and quality of coal.	Price per unit.	Cost of street lighting (if any) compared with gas.	Price of gas per 1,000 feet.	Name and address of engineer-in-chief.	Additional remarks.	Total cost of mains.	Total works' cost per unit.	Total cost per unit, including depreciation, redemption and management charges.	Approximate number of units generated during six months.	Number of units consumed during six months.	Yearly revenue per 8-C.P. lamp.	Averaged daily consumption of watts; daily output in watts for six months
d	.. ..	.. ..	.. ..	Welsh	1s. 3d. per hour for 16 C.P.	..	1s 6d.	J. M. Cook	Several motors are used for printing, grinding, stone mason's work, &c.	..	..	..	..	..	8l.	
d, Cal-id sys-	40	£35,000	.. ..	10 lbs.	6d.	Double	2s. 8d.	M. C. Ollsson	.. ..	£8,000						
ound, cul-copper eders; solid distri-ns	6,260 yards	.. ..	.. ..	.. ..	8d.	..	2s. 7d.	J. C. Vaudrey, M. I. E. E., 14, Dale End, Birmingham	.. ..							
l Sie-oured	.. ..	.. ..	.. ..	.. ..	..	..	..	.. ..	.. ..							
..	½ mile	.. ..	.. ..	.. ..	..	..	..	R. Bailton Brown	Lamps run during summer season							
d ar-bles	4 miles	£41,000	.. ..	Welsh, 21s.	7d.	..	2s. 9d.	Arthur Wright	.. ..	..	..	..	..	107,000	..	97,000 maximum output
insu-s	14 miles	.. ..	.. ..	.. ..	7d.	..	2s. 9d.	G. J. Philpot	.. ..							
	6 or 8 hundred yards	£1,200	No data	.. ..	25s. per lamp per annum	..	4s. 6d.	Rogers & Son	.. ..							
d, lead araffin ation	1,800 yds.	£2,000	.. ..	.. ..	£1 per year, 16 C.P.	..	6s. 8d.	George Reed, The Factory, Chagford	.. ..							
d un-	14 miles of street	£14,000	75 per cent.	6·3 lbs. Welsh	1s. to 6d. sliding scale; first year averages 7d.	Same	4s. 6d.	A. H. Pott	.. ..	..	..	..	47,600	..	10s. 6d.	
fluid	About 4 miles	£2,000	Stated to be 85 per cent.	14 lbs., 6s. per ton	6d. per hour for arcs	..	3s. 9d.	R. S. Mytton	This company does street lighting only							
d vul-ber in pes	20 miles	£31,000	.. ..	Welsh	7d.	..	3s.	M. Ruddle	.. ..							
l insu-bles cast	9 miles	.. ..	70 per cent.	9 lbs., Best Welsh, 23s. per ton	9d.	..	3s. 2d.	H. W. Wilkinson. Central Station, Eastbourne Electric Light Company	.. ..	..	..	..	..	110,000	10s.	
Varing d ca-tric)	About 9 miles	£16,000	Over 85 per cent. at full load	10·8 lbs. Nixon's Navigation	7½d., or by contract, 1s. per C.P.	..	3s. 1d.	T. P. Wilmshurst, Electric Light Station, Exeter	.. ..	£4,000	2·4d.	5d.	85,000	..	8s. by contract 11s. by meter.	114,000 maximum load
d un-	16 miles	£5,000 (with mains)	.. ..	Welsh	1s. per C.P. per annum.	About the same	3s. 9d.	.. ..	Meters being put in, 8d. per unit	..	..	..	..	..	8s.	20,000
and	4 miles	.. ..	.. ..	.. ..	5d.	..	5s. 9d.	J. E. Pearce, Electric Lgt. Co., Galway	Water power (13 feet head) obtained from lake 15 by 20 miles	..	..	..	..	16,000	..	
in cul-	.. ..	.. ..	.. ..	.. ..	7d.	..	2s. 9d.	W. Arnot	.. ..							
res	10 miles	.. ..	.. ..	.. ..	8d., or by contract	..	2s. 2d.	Managing director, W. Emmott	.. ..							
l	30 miles	.. ..	.. ..	.. ..	9d.	..	3s. 9d.	E. T. Mercer	.. ..							
John-hillips tors	.. .. ..	.. ..	.. ..	.. ..	1s. per C.P. per annum	..	4s.	W. R. Rice, engineer in charge	.. ..							
l Cal-em.	50 miles	.. ..	.. ..	.. ..	7½d.	..	3s.	A. Bromley Holmes	.. ..	..	..	..	..	350,000		
l cop-nnedy s. In-ole in onduit	Total length of streets in which mains have been laid, 8·8 miles	.. ..	No data	5·7 for December	7d. per Board of Trade unit	..	3s.	Prof. A. B. W. Kennedy, F.R.S., M.I.C.E.	.. ..							
l Cal-ebber ncrete d Cal-umen wing- and nts	About 20 miles	.. ..	No data	Welsh	8d. per Board of Trade unit	..	3s. 1d.	Frank King	.. ..							
l bare n on	8 miles, including	.. ..	Over 80 per cent.	Average of 7 lbs. through-	7d.	..	3s. 1d.	Sydney T. Dobson,	.. ..							

BATH	City of Bath Electric Lighting Co.	June, 1891	June 24th, 1890	Thomson-Houston for street lighting, Brush alternating for private lighting	Steam	Babcock-Wilcox boilers, Raworth's engines 600 H.P.	10 1,200-C.P.	6,200 8-C.P.	84 arcs	2,200	Contract for seven years	10,000 incandescent, 200 arcs	Underground, Callender's solid system	40	£35,000
BIRMINGHAM ..	Birmingham Electric Supply Co., Ltd.	August, 1889	April, 1891	Low tension Crompton dynamos	Steam	Willans & Robinson steel Lancashire type	38 arcs, 1,500 C.P.	7,900 16-C.P.	.. ..	18 arcs, 2,700 16-C.P.	Provisional order ..	10,000 16-C.P., ultimate capacity 25,000 lamps	Underground, Crompton culvert with copper strip for feeders; Callender's solid system for distributing mains	6,260 yards	..
BRADFORD	Corporation	.. ..	.. ..	2-wire low tension Siemens dynamos and batteries	Steam	Willans engines Lancashire boilers	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	Undergroutd Siemens armoured cable	.. ..	..
BRIDLINGTON ..	Local authority	.. ..	1890	Thomson-Houston arc lighter	..	Motive power hired from saw mill	18 arcs of 1,200 C.P.	.. ..	.. ..	.. ..	.. ..	.. ..	.. .. ..	½ mile	..
BRIGHTON	Corporation	1883	1891	2-wire low tension Goolden dynamos	Steam	Willans engines and Lancashire boilers	.. ..	Equal to 11,800 8-C.P.	.. ..	8,000	.. ..	8,000 8-C.P.	Underground armoured cables	4 miles	£41,000
,, ...	Brighton and Hove Electric Light Co.	.. ..	.. ..	Alternating current transformers	Steam	Fowler boilers and engines	.. ..	16,000 8-C.P.	.. ..	.. ..	.. ..	.. ..	Overhead insulated cables	14 miles	..
BUCKINGHAM ..	Buckingham Elec. Light Co. (private)	1889	1890	Low pressure and accumulators. Two Elwell-Parker dynamos	Steam and water	20 H.P. by water, 20 by steam	.. ..	3,004 16-C.P.	none	50	License	.. ..	Overhead	6 or 8 hundred yards	£1,200
CHAGFORD	G. H. Reed	.. ..	Sept. 1st, 1891	Alternating transformer (Hedgehog) Siemens Bros. dynamos	Water	.. .. ..	.. ..	300 8-C.P.	20 32-C.P.	.. ..	Contract	.. ..	Underground, lead covered paraffin paper insulation	1,800 yds.	£2,000
CHELMSFORD ..	Crompton & Co.	1890	May 14th, 1890	Alternating current and continuous arc lighting	Steam	Multi-Lancashire & Paxman boilers, Willans engines	19 10-ampères	1,500 private, 1,000 street, 8-C.P.	19 arcs, 250 32-C.P. in.,	1,000	Bd of Trade license	4,000	Overhead and underground	14 miles of street	£14,000
COWPEN QUAY and WATERLOO, BLYTH	Sanderson & Co.	.. ..	.. ..	Brush arc lamp in series	Steam	Babcock boiler, Chandler engine	19 2,000-C.P.	Only nine in station	19 arc lamps	.. ..	Contract for five years	25 lamps of 2,000 C.P.	Overhead fluid insulator	About 4 miles	£2,000
DUBLIN	Corporation	1890 and 1892	September, 1892	High tension alternating for incandescent direct for arc currents	Steam	3 compound engines of 350 H.P. 3 compound 751 H.P.	80 arcs of 1,200 C.P.	1,200 16-C.P.	80	.. ..	.. ..	10,000 8-C.P.	Underground vulcanised rubber in cast iron pipes	20 miles	£31,000
EASTBOURNE ..	Eastbourne Elec. Light Company	1891	Feb., 1892	Lowrie-Parker alternators and Lowrie-Hall transformers in parallel, transforming from 1800 to 100 in consumers' houses. Series circuit for arc lighting; Brush arc machines	Steam	Fowler & Co.'s engines and boilers, total engine H.P. 400	20 2,000-C.P.	7,000 8-C.P.	16 arc lamps	1,000	License	4,500 16-C.P.	Underground insulated cables drawn into cast iron pipes	9 miles	..
EXETER	Exeter Electric Light Co.	1891	September, 1889	High tension alternating (Mordey). High tension series arc (Thomson-Houston)	Steam	Two compound horizontal non-condensing 120 H.P., each by Fowler; and two Westinghouse triple expansion of 25 H.P.	35 of 1,200 C.P.	4,000 8-C.P.	None	1,300 8-C.P.	Provisional order	7,000 8-C.P.; 60 arcs	Fowler-Waring underground cable (concentric)	About 9 miles	£16,000
FAREHAM	Fareham Electric Light Co.	.. ..	September 1st, 1890	Thomson-Houston	Steam	Ransome, Sims and Co. com. engine	21 1,200-C.P.	92 20-C.P., 330 16 C.P.	20 arcs; 90 incand.	.. ..	Contract for three years	.. ..	Overhead and underground	16 miles	£5,000 (with
GALWAY	Galway Electric Co.	1890	June, 1889	Low tension. Crompton and Statter dynamos	Water Power	2 100-H.P. Hercules turbines, 12-foot fall	2 2,000-C.P. 1½d. per hour	340 8-C.P., 2 500-C.P., 3 200-C.P., 3d. per hour	Two arcs	150 8-C.P.	Provisional order	3,000 to 4,000 8-C.P.	Underground and overhead	4 miles	..
GLASGOW	Corporation	.. ..	.. ..	Low pressure 3-wire	..	Willans engines	.. .. ..	.. ..	..	.. ..	.. ..	12,000	Bare copper in culverts	.. ..	..
HALIFAX	Halifax Mutual Electric Light & Power Supply Co., Ltd.	None	January, 1889	Low tension, two wire, 110 volts. Blakey, Emmott & Co.'s dynamos	Steam	Two Lancashire boilers, 150 I.H.P. each	80 2,000-C.P. (10d.)	400 16-C.P.	None	100 16-C.P., 10 arcs.	.. ..	2,000 lamps of 8-C.P. At present fully loaded	Overhead wires	10 miles	..
HASTINGS	Hastings and St. Leonard's Electric Light Co.	.. ..	.. ..	Alternate current transformer. Mordey	Steam	Brush	.. ..	4,000 8-C.P.	..	.. ..	.. ..	.. ..	Underground	30 miles	..
KESWICK	Keswick Electric Light Co.	No Provisional order	Sept. 1st, 1889	Alternate current transformers (Kapp 30 unit made by Johnson and Phillips)	Water	Turbines (Victor) 63 H.P.	1 300-C.P. 1s. per hour	730 17-C.P.	..	.. ..	Contract	.. ..	Overhead on Johnson and Phillips fluid insulators	.. ..	..
LIVERPOOL	Liverpool Electric Supply Co.	1889, 1891, and 1892	1883	Direct current, 110 volts, Siemens and Crompton dynamos	Steam	Willans engines, Lancashire boilers 2,000 H.P. indicated	20 1,000-C.P. to 2,000 C.P. each	18,000 16-C.P.	None	2,000 16-C.P.	Provisional orders	37,000 16-C.P.	Underground Callender system.	50 miles	..
LONDON districts:															
BELGRAVIA and PIMLICO	Westminster Electric Supply Corporation	August 26, 1890	March 2nd 1891	Generation at 200, and distribution in two parallels of 100 volts each. Battery in parallel with 200-volt dynamo, Crompton and Siemens dynamos	Steam	Willans and Davey-Paxman engines, Davey-Paxman "Economic" boilers and Fraser of same kind. Total I.H.P. 760 (not yet condensing)	.. ..	Total three stations 98,820 8-C.P.	None	.. ..	Provisional order	30,800 8-C.P.	Underground copper in Kennedy type culverts. Insulated cable in Callender conduit	Total length of streets in which mains have been laid, 8·8 miles	..
CHELSEA parish and a portion of KENSINGTON parish.	Chelsea Electricity Supply Co., Ltd.	Sept. 1886, for Chelsea; Aug. 1889, for Kensington	September, 1889	Low pressure and secondary batteries (E.P.S.) in sub-stations with continuous current motor transformers, constant pressure at feeding points. Elwell-Parker dynamo	Steam	7 Willans & Robinson G. G. engines 80 I.H.P., two Willans & Robinson H. H. engines 125 I.H.P. Babcock and Mill's boilers	Two	35,000 8-C.P	None	8,000 8-C.P.	Provisional order	40,000 8-C.P.	Underground Callender - Webber bitumen concrete conduits and Callender's bitumen cable. Drawing-in system and feeding points	About 20 miles	..
ST. JAMES'S, WESTMINSTER	St. James's and Pall Mall Electric Light Co., Ltd.	License, 1888; provisional order 1890	April 4th, 1889	Three-wire continuous low-pressure currents from dynamos by Siemens Bros., and Latimer Clark, Muirhead	Steam	Willans engines, 3,300 indicated H.P., six Davey-Paxman loco boilers, 3,600 effective H.P.	About 50 scattered over the district	45,000 8-C P.	..	8,000 8-C.P.	Provisional order	60,000 8-C.P., 100,000 wired	Underground bare copper strip on porcelain insulators in iron culvert, armoured cable, iron pipes and vulcan. rubber services	8 miles, including services and small cable runs	..
KENSINGTON ..	Kensington and Knightsbridge Electric Lighting Co., Ltd.	Licenses & provisional orders obtained, 1887 and 1888	Jan., 1887	Low tension with secondary batteries, Siemens and Crompton & Co. dynamos	Steam	Willans engines 1,800 H.P., Babcock boilers 2,180 H.P.	.. ..	46,039 8-C.P.	..	9,203 8-C.P.	Provisional order	56,865 8-C.P.	Underground copper strip in culvert and Henley's cable in iron pipes, three wire and feeder systems	11 miles and 700 yards	..
LONDON	Electric Supply Corporation	1889	1889	High tension 10,000 volts, Ferranti	Steam	Hick Hargreaves	95	47,000 16-C.P.	..	16,000	.. ..	100,000	Underground concentric	70 miles	..
,, ...	Metropolitan Electric Supply	.. ..	.. ..	Low pressure, continuous moderate pressure	..	.. ..	.. ..	126,000 of 8-C.P.	..	..	..	..	.. ..	.. ..	..
ST. MARY ABBOTTS, KENSINGTON ..	House to House Electric Supply Co., Ltd.	1889	March, 1889	Alternating current transformer System. Lowrie-Hall	Steam	Compound horizontal engines and water tube boilers, about 1,100 H.P. total	.. ..	25,000 10-C.P., about 1s. 4d per hour	None	4,000 10-C.P.	Provisional order	30,000 8-C.P. lamps installed	Underground in cast iron pipes	26 miles	..
ST. MARTIN'S-IN-THE FIELDS ..	Electricity Supply Corporation, Ltd.	.. ..	Oct. 29th, 1890	Direct current, low tension, 100 volts. Mather and Platt dynamos	Steam	Willans & Robinson 1,600 H.P.	10 2,000-C.P.	25,000 8-C.P.	None	15,000 8-C.P.	Provisional order	45,000 8-C.P.	Underground Callender cables run in Callender bitumen casing	14 miles	..
MAYFAIR	Westminster Electric Supply Corporation, Limited	August 26, 1889	March 24th 1891	This station is still working on 2-wire system with batteries in parallel with dynamos, but is about to be	Steam	Willans engines, Paxman "Economic" boilers, and similar boilers by Fraser, Total 1560 I.H.P., non-con-	About six arcs	.. ..	None	.. ..	Provisional order	62,500 8-C.P.	Underground copper in Kennedy type culvert. Insulated cable in Callender conduits	Total length of streets in which mains have been	..

, Cal- d sys-	40	£35,000	.. ..	10 lbs.	6d.	Double	2s. 8d.	M. C. Olsson	.. ..	£8,000							
und, cul- pper lers ; solid listri- s	6,360 yards	.. ..	.. ..	.. ..	8d.	..	2s. 7d.	J. C. Vaudrey, M. I. E. E., 11, Dale End, Birmingham	.. ..								
Sie- ured	.. ..	.. ..	.. ..	.. ..	..	..	..	.. ..	.. ..								
..	½ mile	.. ..	.. ..	.. ..	..	..	..	R. Hailton Brown	Lamps run during summer season								
ar- es	4 miles	£41,000	.. ..	Welsh, 21s.	7d.	..	2s. 9d.	Arthur Wright	.. ..	..	..	..	..	107,000	..	17,000 maximum output	
insu-	14 miles	.. ..	.. ..	.. ..	7d.	..	2s. 9d.	G. J. Philpot	.. ..								
	6 or 8 hundred yards	£1,200	No data	.. ..	25s. per lamp per annum	..	4s. 6d.	Rogers & Son	.. ..								
lead affin tion	1,800 yds.	£2,000	.. ..	.. ..	£1 per year, 16 C.P.	..	6s. 8d.	George Reed, The Factory, Chagford	.. ..								
un-	14 miles of street	£14,000	75 per cent.	6·3 lbs. Welsh	1s. to 6d. sliding scale; first year averages 7d.	Same	4s. 6d.	A. H. Pott	.. ..	..	..	..	..	47,600	..	10s. 6d.	
uid	About 4 miles	£2,000	Stated to be 85 per cent.	14 lbs., 6s. per ton	6d. per hour for arcs	..	3s. 9d.	R. S. Mytton	This company does street lighting only								
vul- er in es	20 miles	£31,000	.. ..	Welsh	7d.	..	2s.	M. Ruddle	.. ..								
insu- les cast	9 miles	.. ..	70 per cent.	9 lbs., Best Welsh, 23s. per ton	9d.	..	3s. 2d.	H. W. Wilkinson. Central Station, Eastbourne Electric Light Company	.. ..	..	..	..	..	110,000	10s.		
aring ca- ric)	About 9 miles	£16,000	Over 85 per cent. at full load	10·8 lbs. Nixon's Navigation	7½d., or by contract, 1s. per C.P.	..	3s. 1d.	T. P. Wilmshurst, Electric Light Station, Exeter	.. ..	£4,000	2·4d.	5d.	85,000	..	8s. by contract 11s. by meter.	114,000 maximum load	
un-	16 miles	£5,000 (with mains)	.. ..	Welsh	1s. per C.P. per annum.	About the same	3s. 9d.	.. ..	Meters being put in, 8d. per unit	..	..	..	..	..	8s.	20,000	
and	4 miles	.. ..	.. ..	.. ..	5d.	..	5s. 9d.	J. E. Pearce, Electric Lgt. Co., Galway	Water power (13 feet head) obtained from lake 15 by 20 miles	..	..	..	..	16,000	..		
cul-	.. ..	.. ..	.. ..	.. ..	7d.	..	2s. 2d.	W. Arnot	.. ..								
s	10 miles	.. ..	.. ..	.. ..	8d., or by contract	..	2s. 2d.	Managing director, W. Emmott	.. ..								
	30 miles	.. ..	.. ..	.. ..	9d.	..	3s. 9d.	E. T. Mercer	.. ..								
ohn- llips rs	.. ..	.. ..	.. ..	.. ..	1s. per C.P. per annum	..	4s.	W. R. Rice, engineer in charge	.. ..								
Cal- n.	50 miles	.. ..	.. ..	.. ..	7½d.	..	3s.	A. Bromley Holmes	.. ..	..	..	..	..	350,000			
cop- nedy In- e in nduit	Total length of streets in which mains have been laid, 8·8 miles	.. ..	No data	5·7 for December	7d. per Board of Trade unit	..	3s.	Prof. A. B. W. Kennedy, F.R.S., M.I.C.E.	.. ..								
Cal- ober rete Cal- men ring- and s	About 20 miles	.. ..	No data	Welsh	8d. per Board of Trade unit	..	3s. 1d.	Frank King	.. ..								
bare on nsu- cul- ured ipes rub-	8 miles, including services and small cable runs	.. ..	Over 80 per cent.	Average of 7 lbs. throughout the year (1891) Welsh	7d.	..	3s. 1d.	Sydney T. Dobson, A.M.I.C.E., of Mason's Yd., Duke Street, St. James's	.. ..								
cop- cul- ey's iron wire sys-	11 miles and 700 yards	.. ..	83 per cent. full load, 76 per cent. half. Mean 81 per cent.	Best in any one month, 6·5 lbs. Welsh	8d., with rebate to large consumers according to scale	..	3s. 1d.	R. E. Crompton, Mansion House Buildings, E.C.	.. ..								
con-	70 miles	.. ..	.. ..	Welsh, 15s. 6d.	7d.	..	2s. 6d. & 3s.	P. Walter d'Alton	.. ..								
	.. ..	.. ..	.. ..	.. ..	7½d.												
in s	26 miles	.. ..	No data	Anthracite	8d., subject to discounts	..	..	Albert Gay	.. ..	£18,800							
Cal- run itu-	14 miles	.. ..	No data	.. ..	7½d.	..	3s. 1d.	H. A. Earle, Mather and Platt, 16, Victoria Street, S.W.	.. ..								
cop- edy In- in on-	Total length of streets in which mains have been	.. ..	No data	.. ..	7d.	..	3s.	Prof. Kennedy	.. ..								

				namo											
ST. JAMES'S, WESTMINSTER	St. James's and Pall Mall Electric Light Co., Ltd.	License, 1888; provisional order 1890	April 4th, 1889	Three-wire continuous low-pressure currents from dynamos by Siemens Bros., and Latimer Clark, Muirhead	Steam	Willans engines, 3,300 indicated H.P., six Davey-Paxman loco boilers, 3,600 effective H.P.	About 50 scattered over the district	45,000 8-C P.	..	8,000 8-C.P.	Provisional order	60,000 8-C.P., 100,000 wired	Underground bare copper strip on porcelain insulators in iron culvert, armoured cable, iron pipes and vulcan. rubber services	8 miles, including services and small cable runs	.. ..
KENSINGTON ..	Kensington and Knightsbridge Electric Lighting Co., Ltd.	Licenses & provisional orders obtained, 1887 and 1888	Jan., 1887	Low tension with secondary batteries, Siemens and Crompton & Co. dynamos	Steam	Willans engines 1,800 H.P., Babcock boilers 2,180 H.P.	.. ..	46,039 8-C.P.	..	9,203 8-C.P.	Provisional order	56,865 8-C.P.	Underground copper strip in culvert and Henley's cable in iron pipes, three wire and feeder systems	11 miles and 700 yards	.. ..
LONDON	Electric Supply Corporation	1889	1889	High tension 10,000 volts, Ferranti	Steam	Hick Hargreaves	95	47,000 16-C.P.	..	16,000	.. ..	100,000	Underground concentric	70 miles	.. ..
,, ...	Metropolitan Electric Supply	.. ..	.. ..	Low pressure, continuous moderate pressure	..	.. ..	.. ..	126,000 of 8-C.P.	..	..	..	..	.. ..	.. ..	.. ..
ST. MARY ABBOTTS, KENSINGTON ..	House to House Electric Supply Co., Ltd.	1889	March, 1889	Alternating current transformer System. Lowrie-Hall	Steam	Compound horizontal engines and water tube boilers, about 1,100 H.P. total	.. ..	25,000 10-C.P., about 1s. 4d per hour	None	4,000 10-C.P.	Provisional order	30,000 8-C.P. lamps installed	Underground in cast iron pipes	26 miles	.. ..
ST. MARTIN'S-IN-THE FIELDS ..	Electricity Supply Corporation, Ltd.	.. ..	Oct. 29th, 1890	Direct current, low tension, 100 volts. Mather and Platt dynamos	Steam	Willans & Robinson 1,600 H.P.	10 2,000-C.P.	25,000 8-C.P.	None	15,000 8-C.P.	Provisional order	45,000 8-C.P.	Underground Callender cables run in Callender bitumen casing	14 miles	.. ..
MAYFAIR	Westminster Electric Supply Corporation, Limited	August 26, 1889	March 24th 1891	This station is still working on 2-wire system with batteries in parallel with dynamos, but is about to be changed over. Elwell-Parker and Crompton dynamos	Steam	Willans engines, Paxman "Economic" boilers, and similar boilers by Fraser, Total 1560 I.H.P., non-condensing	About six arcs	.. ..	None	.. ..	Provisional order	63,500 8-C.P.	Underground copper in Kennedy type culvert. Insulated cable in Callender conduits	Total length of streets in which mains have been laid, 9·5 miles	.. ..
NOTTING HILL ..	Notting Hill Elec. Light Company	.. ..	May, 1891	Direct current Crompton's dynamos	Steam	Willans engines, Babcock & Wilcox boilers	Seven	10,000 8-C.P.	..	2,500	Provisional order	20,000	Underground, three-wire system	8 miles	£20,000
ST. PANCRAS ..	Electricity department of the Vestry	1883	Nov. 9th, 1891	Continuous current 110 volts. 3-wire system, Kapp's multipolar dynamos	Steam	Willans triple expansion engines, Babcock & Wilcox boilers	.. ..	11,000 16-C.P.	86 arcs being erected	8,000	Provisional order	10,000 16-C.P., 90 arcs	Underground culvert. Bare copper strip on insulators	5½ miles	£92,000, including mains
WESTMINSTER ..	Westminster Electric Supply Corporation, Limited	Aug. 26th, 1889	Nov. 11th, 1890	Generation at 200 volts and distribution in two parallels of 100 volts. each; batteries in parallel with 200-volt dynamos, Goolden, and Mather and Platt	Steam	Willans engines, Babcock boilers, total I.H.P. of engines 1,120 (not yet condensing)	About a dozen arcs	.. ..	None	.. ..	Provisional order	45,000 8-C.P.	Underground. Copper in Crompton culverts and insulated cable in pipes and casing	Total length of streets in which mains are laid, 4·8 miles	.. ..
LYNTON	Hans H. Benn	.. ..	.. ..	Alternate current transformer	Water	C. L. Hett's turbine	.. ..	1,200 8-C.P.	378 C.P.	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
NEWCASTLE	Newcastle and District Electric Lighting Co., Ltd.	.. ..	.. ..	Alternate current transformers	Steam	Parsons's turbines	.. ..	10,500	.. ..	.. ..	License	Ultimate capacity will be 50,000	Underground	.. ..	.. ..
,, ...	Newcastle Electric Supply Co.	1890	1890	Alternate current transformer 2,000 volts, Mordey	Steam	Robey engines, Lancashire boiler	.. ..	14,366 8-C.P.	.. ..	.. ..	. ..	.. ..	Underground concentric cables	10 miles	.. ..
NORTHAMPTON ..	Northampton Elec. Light and Power Co., Ltd.	1890	March, 1891	Direct current low tension. Crompton dynamos	Steam	Three Scott & Hodgson's compound engines, 120 I.H.P. each; two Daniel Adamson Lancashire boilers, 120 lbs. steam	20 from 5 to 20 ampères	4,000 8-C.P.	7 160-C.P.	1,000 8-C.P.	Provisional order	7,000 8-C.P.	Crompton's underground mains	2 miles	£7,000
NOTTINGHAM ..	Muirhead and Co.	.. ..	March, 1891	Low tension. Clark, Muirhead and Co.	Steam	Marshall & Co.	4 arcs, 2,000 C.P.	600 16-C.P.	.. ..	200	License	570 16-C.P	Overhead wires	1 mile	£3,000
OXFORD	Oxford Electric Light Co.	.. ..	June, 1892	H.T. continuous Parker dynamos motor generator transformers at sub-stations	Steam	Triple expansion surface condensing engines loco. boilers	16 1,200-C.P.	5,000 8-C.P.	16 arcs	All since June, 1892	P.O.	15,000 8-C.P.	H. T. Silvertown, L. T. Callenders lead covered	8 miles L.T. 7 miles H.T.	.. ..
PRESCOT	British Insulated Wire Co.	.. ..	September, 1892	Brush alternating system	Steam	Raworth, Browett and Tangye	12 2,000-C.P.	1,000 12-C.P.	12 arcs	.. ..	.. ..	5,000	Underground B.I.W. system	12 miles	£7,000 approximate
PRESTON	National Elec. Supply Co., Ld., Preston	1890	Oct., 1890; temporary plant	3-wire low tension system, Latimer Clark, Muirhead and Co.	Steam	Bellis compound	Fifty	6,000 8-C.P.	.. ..	3,000 8-C.P.; 30 arcs	.. ..	30,000 8-C.P.	Underground 3-wire	5 miles	.. ..
READING	Laing, Wharton and Down Syndicate	.. ..	March, 1889	Thomson-Houston	Steam	Two Browett-Lindley 25 H.P. and Westinghouse, one at 50 H.P., one at 25 H.P.	71 arcs of 1,200 C.P.	600 8-C.P.	None	.. ..	Agreement with Corporation	Plant fully loaded	Overhead	4½ miles	.. ..
SHEFFIELD	Sheffield Elec. Light and Power Co.	.. .	.. ..	Alternate current transformer	Steam	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	6,000 8-C.P.	.. ..	.. ..	.. ..
SOUTHAMPTON ..	Southampton Elec. Light Company	1890	May, 1891	Low tension 3-wires with batteries, Crompton dynamos	Steam	Two Marshall boilers, 20 and 40 N.H.P.; one Robey 40 N.H.P. engine; Willans, 60	13 arcs	2,500 8-C.P.	None	1,500	License	2,700 8-C.P.	Underground Crompton system	1½ mile	£4,200
TAUNTON	Taunton Elec. Light Co.	.. ..	1886	Thomson-Houston	Steam	Willans	78 arcs	920 16-C.P.	37 arcs	7 arcs and 500 8-C.P.	Provisional order	90 arcs, 1,300 16-C.P.	Overhead and underground	8 miles	.. ..
THETFORD	Electric Light Co., Ltd.	.. ..	August, 1888	Lawrence, Scott dynamos	Steam	Burrell and Sons engines, 1·25 H.P. 1·10 H.P.	20 500-C.P.	450 16-C.P.	.. ..	.. ..	P.O.	1,000 16-C.P.	Overhead	3 miles	£3,000
WEYBRIDGE	Weybridge Elec. Light Company	June, 1891	March, 1890	Thomson-Houston system	Steam	Two 75 H.P. compound engines; one 100 H.P. boiler	.. ..	500 16-C.P.	120 16-C.P.	3,505 16-C.P.	Provisional order	1,200	Overhead	7 miles	.. ..
WATERFORD	Waterford Elec. Light Company	.. ..	Sept., 1887	Thomson-Houston system, four T.-H. arc dynamos, and two T.-H. composite field alternators	Steam	120 H.P. Fowler (horizontal), 120 Marshall, two loco. boilers	34 1,200-C.P.	None	34 1,200-C.P., back streets lighted by oil	.. ..	Contract	Working at full capacity	Overhead	.. ..	.. ..
WICKWAR	.. ..	.. ..	October, 1888	2-wire 200 volts, Elwell-Parker	Steam and water	Davey-Paxman 60 I.H.P., Adams 15 I.H.P., one 36 feet overshot water-wheel	.. ..	220	20 incan.	5 public	Public subscriptions.	240 16-C.P.	Overhead bare copper wires	2½ miles	£700

miles, ncluding ervices nd small able uns	.. ..	Over 80 per cent.	Average of 7 lbs. throughout the year (1891) Welsh	7d.	..	3s. 1d.	Sydney T. Dobson, A.M.I.C.E., of Mason's Yd., Duke Street, St. James's	.. ..								
miles nd 700 ards	.. ..	83 per cent. full load, 76 per cent. half. Mean 81 per cent.	Best in any one month, 6·5 lbs. Welsh	8d., with rebate to large consumers according to scale	..	3s. 1d.	R. E. Crompton, Mansion House Buildings, E.C.	.. ..								
miles	.. ..	.. ..	Welsh, 15s. 6d.	7d.	..	3s. 6d. & 3s.	P. Walter d'Alton	.. ..								
. ..	.. ..	.. ..	.. ..	7½d.												
miles	.. ..	No data	Anthracite	8d., subject to discounts	..	..	Albert Gay	.. ..	£18,800							
miles	.. ..	No data	.. ..	7½d.	..	3s. 1d.	H. A. Earle, Mather and Platt, 16, Victoria Street, S.W.	.. ..								
otal ngth of reets in hich ains ve been id, 9·5 iles	.. ..	No data	.. ..	7d.	..	3s.	Prof. Kennedy	.. ..								
miles	£30,000	75 per cent.	Between 8 and 9 lbs.	8d.	..	3s. 1d.	George Schulz, Central Station, Bulmer Place, W.	.. ..	..	..	..	..	..	10s.		
miles	£92,000, including mains	No data	.. ..	6d.; and 3d. for day supply	..	3s. 9d.	J. T. Baron, M.I.E.E., Vestry Hall, St. Pancras	.. ..	£34,894							
otal ength of treets in hich ains re laid, ·8 miles	.. ..	No data	.. ..	7d.	..	3s.	Prof. A. B. W. Kennedy	.. ..								
. ..	.. ..	.. ..	.. ..	.. ..	..	..	Hans H. Benn	.. ..								
. ..	.. ..	.. ..	.. ..	4½d.	..	1s. 9½d.	W. O. Hunter	.. ..								
miles	.. ..	46 per cent.	21 lbs. steam coal 5s. 10d.	4½d.	..	1s. 10d.	.. ..	Figures given are for twelve months working	..	2·9d.	..	327,891	244,470			
miles	£7,000	No data	Hard Steam, 12s. 9d.	9d. a unit, subject to 10 per cent. discount	..	2s. 4d.	B. R. Beale, Angel Lane, Northampton	.. ..	..	..	..	30,000				
mile	£3,000	.. ..	10s. 3d.	7d. or 30s. per 16 C.P. per annum	..	2s. 6d.	J. Parr	.. ..	..	..	..	..	..			
miles L.T. miles H.T.	.. ..	.. ..	Welsh	8d.	..	..	J. H. M. Mc Lean	.. ..								
miles	£7,000 approximate	80 per cent.	Steam coal	7d.	..	4s. 8d.	.. ..	.. ..	£3,000	..	..	..	..	10s. 6d. to 15s.		
miles	.. ..	.. ..	Slack	15 per cent. discount if paid within twenty one days	..	1s. 9d.	F. F. Bennett, Laurel Villas, Ashton-on-Ribble, Preston	Transformed from temporary to permanent station	..	..	..	41,000	40,000	6s. 8d.	100,000 daily output.	
miles	.. ..	No data	Coke	Arc by contract. Incandescent by meter	..	3s.	F. F. Yeatman, The Island, Reading	.. ..								
.. ..	.. ..	.. ..	.. ..	.. ..	..	..	.. ..	Company object to give details on account of alterations								
mile	£4,200	4,000	Welsh at 17s. 9d.	10d., with rebate	..	2s. 10d.	K. A. Scott-Moncrieff	.. ..	£6,000	3·5d.	..	24,000	22,000	..	12,200	
miles	.. ..	.. ..	16s. per ton	6d.	..	3s. 9d.	H. E. Hunt	.. ..								
miles	£3,000	.. ..	Cobbles, 17s. 6d.	8d.	..	5s.	R. Carter	.. ..								
miles	.. ..	.. ..	9 lbs.	9d.	..	4s. 6d.	Percy Mossop, Weybridge Elec. Works	.. ..								
.. ..	.. ..	No data	.. ..	.. ..	..	4s. 6d.	P. Peters, Elec. Light Depot, Waterford	.. ..								
miles	£700	.. ..	Forest of Dean, 10s. per ton	.. ..	..	none made	F. G. Ansell	Street lamps are lit only from Oct. 1st to April 1st	£70	..	4d	4,000				

charge of the motor, the less likelihood is there of the reserve being called into action, and therefore a less margin may be allowed than would otherwise be prudent. Economical running of high pressure engines, the care of the steam generators and economy of fuel, are sciences in themselves, and no amount of theoretical training will give the necessary knowledge. Those who are desirous of taking up electrical engineering as a profession should never forget that success depends upon their attainments being based upon a thorough experience of mechanical engineering.

CENTRAL ELECTRIC LIGHT STATIONS.

THE table which we publish this week relating to central stations is a continuation of the one issued last year. It is interesting, for many reasons. In conjunction with our map, it perhaps shows better than any other means the condition of electric lighting in the country at the present time. There is one point which calls for special comment. The list of questions sent out to the electrical engineers of the country was a most formidable one, yet in only one instance was there a grumble. Of course, we were entirely in the hands of the officials of central stations as to whether information was given or not, and it is a most gratifying incident to find, for the most part, a readiness to help in the compilation of those statistics.

Since our remarks of last year on the position of electric lighting, there have been many hopeful signs of a move forward towards the general adoption of electric lighting. New stations have been erected and begun a supply, older stations have laid down fresh plant and increased their output. The most important work has, however, been done by the local authorities. At Manchester, Huddersfield, Dublin, Hull, Nottingham, Portsmouth, and other places, the town authorities have really thrown great energy into the work of providing a supply of electricity, and we shall watch with great interest the management of these centres of supply. It is our opinion that the result of this will be of the greatest importance. We are unwilling to say that local authorities have anything in common with sheep, but certain it is that the good example of the year will have great effect on the vacillating policy of municipal bodies. It cannot be assumed that local authorities are much to be blamed in the matter of hugging provisional orders. They were naturally unwilling to barter away their rights to joint stock companies, and it was a difficult matter to decide on a consulting engineer. They never for a moment doubted the veracity of consulting engineers, but human nature has many weaknesses, and engineers have very often special fads.

It is even now too early to scrutinise the financial side of an electric supply company, for we do not consider that they have for the most part reached the condition of normal supply. It is not without importance, however, to note that, although small dividends only have been earned, there is a tendency to decrease the price of electricity. In London, the companies, in some instances, have seen fit to lower the price by one penny, which, considering all things, is a good reduction. After the first large influx of customers for electric light, it is found that the increase of lamp connections is somewhat slow. Still every little helps, and no doubt the consumers who come in after much consideration, turn out to be the most remunerative. It seems to be apparent that the companies which ventured to exploit new residential districts, have not been nearly as successful as was at first anticipated. With reason it was assumed that new houses were more likely to take electric light than older ones, simply on account of the ease with which the connections could be made. The assumption turned out fairly accurate, but then the householder began to turn his attention to economising light; the great height of his ambition was to keep his electric light bill as small as the gas bills. Consequently he stopped at home in the evening and devoted all his time in following the servants about to put out the lights. This was by no means good from the point of view of the load curve, and at present the only hope for the company is that the householder may get tired, then the load curve will rise.

Far different is the position of the companies which have such good customers as clubs. Light is required for the greater part of the night, and no other form of lighting than electricity will be used. We have had the pleasure of seeing some electric lighting bills sent in to clubs, and the electric light company has had our inward congratulations. There was, however, a moment in the history of these companies when things looked bad. The secretaries of the clubs met in council, with the result that representations were made to the companies that considerable reductions must be made. For the moment, however, the matter has been adjusted, but it need not be surprising if the subject crops up again.

It will be seen from the table that an attempt has been made to collate figures having reference purely to the efficiency of supply. How little success has attended these efforts may be seen at a glance. It is not to be expected that tests could be carried out merely for the purpose of filling up our columns, but we did expect that tests of machinery would have been more general than they appear to be. At the same time, while we do not fail to appreciate the view of many that to pay a dividend is the first thing for a central station to do, it cannot be denied that judicious tests will show the weakness of a system and a possible means of improvement. There is more information given as to the total cost of central stations than was expected, this item alone should make the table of some value.

Street Lighting: A Plea for the Incandescent Lamp.

SIGNS are not wanting that before the next lighting season has come and gone the vexed question of public lighting by electrical means will have reached a stage where the limits of utility of arc and incandescent lamps will have been to some extent defined. Many attempts have been made to supersede gas jets by incandescent lamps in narrow streets and courts of districts where gas has been displaced by electricity. Varying success has attended these efforts, the result being unsatisfactory at the best. Lamps of varying candle-power, 16, 25, 32, and 50 have been used, but experience has not yet defined what the practice of the future will be. Of course, the difficulty lies in the small area from which in an incandescent lamp the light proceeds and the necessarily small resultant diffusivity. We were struck by this in the case of Winchester, where a converse example is presented; for a visitor to that ancient and historic city could scarcely fail to be struck by the rather brilliant and not unpleasing effect of the oil lamps still maintained for the public service. Owing to the area and shape of the flame the illuminative effect is greater than would be supposed, judging simply from the photo-

metric value of the candle-power at the point of combustion. From what has been done it appears to be more than likely that electric lamps of 16 C.P. will regain some of the prestige they have lost in the last year or two, when applied to exterior illumination. In the country towns, to which electricity is now penetrating, there are many instances in which the larger and more intense arcs are unsuited on account of cost. In natural sequence the leading thoroughfares, important squares, and business streets, are the first to be blessed with the attentions of the progressive municipal councillor, and for these the dazzling arc is not only suitable but harmonious. Later on, when the smaller streets and alleys with their side courts are considered, a choice has to be made between leaving them to the tender mercies of the gas company or providing incandescent lamps. When the public, to whom the word "electric" has up till recently conveyed the impression of effects great in magnitude and startling in kind, have realised that an incandescent, when used for street lighting, has a sphere of its own, though less of a revolution when judged by results, we shall hope to hear the last of the present superabundance of complaints as to deficient lighting in cases where it is used—complaints which have their origin rather in unfair comparison of dissimilar things than in any intrinsic weakness in the means employed.

Gas Power for Electric Lighting.

THE paper presented by Mr. J. E. Dowson before the Institution of Civil Engineers contains some most interesting facts concerning gas motors. It is certainly marred by some serious inaccuracies, which more or less, affect the conclusions of the author, but they appear to be due more to carelessness in revision than to anything else. The main contention of Mr. Dowson is that using large gas engines would result in a saving of fuel of 50 per cent. No doubt economy might be effected to a great extent by using large gas engines, and certainly the station at Dessau, in the Duchy of Anhalt tends to prove this. But the author's remarks fail to convince one that such a large percentage of saving as he indicates would be made. It is generally conceded that less gas is used in an engine for lighting a house by electricity, than is the case when gas is used as the illuminant. That, of course, is an important fact, but it is by no means everything, for the initial expense of engine and generator, as well as the trouble in tending has to be considered. But the great question is the use of large engines for generating stations. It seems clear, that, at any rate, the Otto cycle will not be the one which can be adopted with great success for electric lighting. It is essential that there should be steady running, and this is not always to be obtained with the Otto cycle. Electric light men are the best judges of what is wanted in central stations, and it seemed a pity the discussion was adjourned before they had the opportunity of speaking.

Electric Railway Trolley-Boys.

PIONEERS of electric railways often tell amusing anecdotes relating to experiences with the early over-running trollies. They consisted of two or four-wheeled trollies (hence the name), running on the top of a single or double overhead wire, and conveyed the current from the line to the car motors. These trollies gave a good deal of trouble, and it was not an unusual sight to see a man sitting on the top of a tramcar in order to hold the trolley in its place. In an article which we print this week relating to the Vevey-Montreux electric railway the services of a trolley-boy or *tubier* is mentioned. We have recently visited the charming island of Guernsey where an electric railway is in operation and where they carry a trolley-boy on each car. He does not sit on the top of the vehicle, but he stands on the rear platform alongside the conductor holding the cord which is attached to the upper end of the trolley pole, and his duty is to watch it. When the trolley wheel jumps off the wire, which happens frequently, he has to replace it at once so that the car should not come to a standstill. At Guernsey, the "under-running" trolley pole is used, but it is placed on one side of the car in order to clear the top seats. There is, evidently, something wrong with the design of this arrangement. On the South Staffordshire lines, which were recently opened to the general traffic, the trolley pole is also placed on one side, and we hear that the trolley wheels frequently jump off the line necessitating a careful watch or perhaps, eventually, also a trolley-boy on each car. It would be interesting to learn whether this difficulty is due to the one-sided everhanging trolley pole.

The Telephone Question.

THE financial newspapers have recently contained letters on the question of telephone rates and the position of the members of the Subscribers' Protection Association as affected by the amalgamation proposals. We hope that the officials of the association will take all effective measures to carry out the modicum of protection which was claimed for their members, but we fear that it will be useless for them to expect much confidence to be placed in any future efforts of their association when it is considered that the only result of their incorporation has been the use of their respective signatures as prospective subscribers to a new company which promptly amalgamates with the old. We are sorry to say that the ventilation of such subjects as the telephone service in the columns of the financial papers has so far never resulted in any practical good. It is always turned to account for financial purposes, and the service or the rates are no longer considered when the financial result has been attained. A series of articles in the *Financial News*, before the amalgamation of the subsidiary companies with the United Company, attacked the latter very strongly, apparently from the point of view of the subsidiary companies. This formed the precedent for subsequent ventilations of the subject. The only effect obtained seems to be financial. No improvement in the service and no reduction in the rates can be expected from such efforts. The service seems to pursue the even, or uneven, tenor of its way and the subscribers have to pay a dividend on a larger capital for every ventilation of the subject.

Depreciation of Machinery.

IN the report issued recently by the St. Pancras Vestry there is one item which seems to be under-estimated, namely, depreciation of plant. It is referred to in the report in the following terms:—"No large provision for depreciation ever will be necessary, because electric lighting plant must be kept in perfect condition by continual repairs and renewals in detail." There must be a mistake somewhere in this matter, for a very large depreciation must be allowed for all working machinery; electric light machinery cannot be an exception to this allowance, in fact it is rather the other way. That such machinery must be maintained in exceptionally good order entails a large expenditure in details renewed and in repairs, even then it depreciates largely in value, especially as there seems to be occasional changes in the fashion, of engines and dynamos. The high-speed specially made engines, just now the pet fashion among experts, have not been long enough under practical hard work to enable any one to say what amount of depreciation may be allowed on them, but it must be at least as large as that on other high-speed engines, and very probably a good deal more. Boilers and valves wear out gradually from the day they are first started. Dynamos and cables, perhaps, do not depreciate quite as much as steam machinery, but the progress of improvement in electrical machinery is now so rapid and important that the owners of electrical machinery, more especially if they are public bodies, ought to reckon with the possibility of their plant being entirely superseded some day by an improved plant for generating electricity; in that case the depreciation would be enormous. Most of the owners of electrical plant working continuously, allow a very substantial amount for depreciation, it therefore seemed to us that such an allowance not being made in the St. Pancras report, attention ought to be called to the omission.

THREE SYSTEMS OF ELECTRIC DISTRIBUTION.*

WHATEVER effect patent litigation may have on the business side of an invention, it certainly is beneficial from a scientific point of view, as it brings out clearly and concisely the principles involved in such inventions. A case in point is the suit of the Edison Electric Light Company against the New Haven Electric Company, the subject being the three-

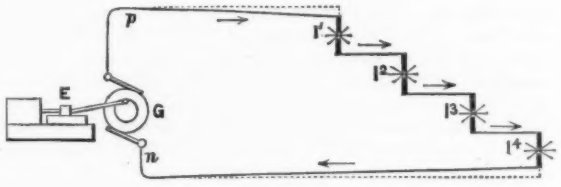

FIG. 1.

wire system of electrical distribution.† Without going into the merits of the case, we extract from the testimony some diagrams and condense some of the descriptive matter to illustrate as clearly as possible three methods of electric distribution. The experts in the case have not only provided very clear electrical diagrams, but have furnished water analogues for each of the cases.

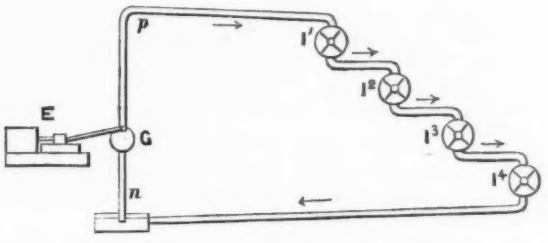

FIG. 2.

In fig. 1 is illustrated the series system commonly employed in electric arc lighting, E being the engine; G, the dynamo or generator; p and n, the positive and negative conductors; and I^1, I^2 I^3, I^4, the arc lamps. In this case, as will be seen, the current passes from the dynamo through all the lamps in series.

FIG. 3.

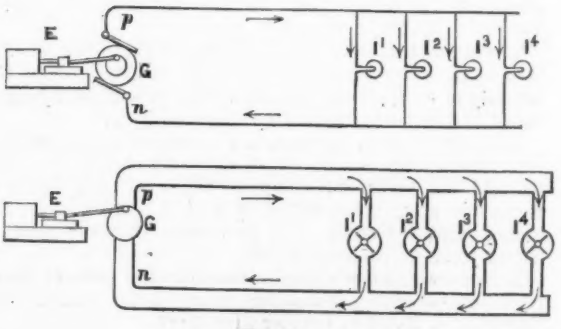

FIG. 4.

In fig. 2 is given the water analogue, in which E is the engine, G the rotary pump, p and n the positive and negative pipes conveying the water, I^1, I^2, I^3, I^4, water motors arranged in series and operated one after the other by the water passing from the motor, I^1, to the motor, I^2, thence to the motor, I^3, and to the motor, I^4, each motor using its proportion of the energy.

In fig. 3 is represented the usual multiple arc or parallel arrangement of incandescent lamps, E, as in the other case, being the engine; G, the generator; p and n, positive and negative conductors; and I^1, I^2, I^3, I^4, lamps taking the current from the positive conductor and delivering it with a certain fall of potential to the negative conductor.

In fig. 4 is illustrated the water analogue of the multiple arc system, E being the engine, G the generator or pump, I^1, I^2, I^3, I^4, water motors taking water from the positive pipe and delivering it to the negative pipe, with a fall of potential due to the amount of energy absorbed in the motors.

In fig. 5 are shown two like multiple arc systems placed parallel with each other, with the positive conductor of one system adjoining the negative conductor of the adjacent system, the arrows indicating the direction of the current in each system. It will be seen that if the same amount of

FIG. 5.

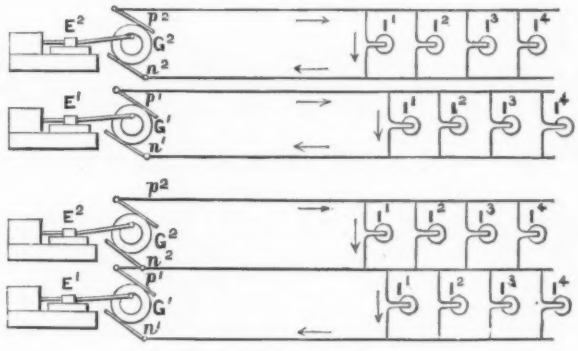

FIG. 6.

energy is absorbed in each of these two systems, the negative conductor, n^2, of the upper system must carry a negative current exactly equal to the positive current carried in the conductor, p^1, of the lower system, and the currents in these two conductors, being equal and opposite, would neutralise each other if carried on the same conductor, as indicated in fig. 6, in which the negative conductor n^2, and positive conductor, p^1, are merged in one. With the generators, G^1

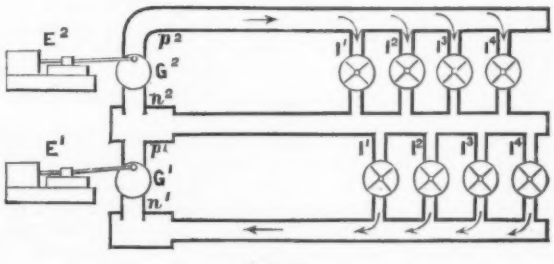

FIG. 7.

and G^2, arranged in series, the electromotive force is 220 volts, which is suited to two 110-volt lamps in series. So long as equal resistances are placed in the two parts of the three-wire circuit, the central wire remains neutral, and no current passes in either direction; but as soon as this balance is disturbed by turning off or adding one or more lamps, a current due to the difference in resistance of the two branches passes over the neutral wire. This system is aptly, though not perfectly, illustrated by the water analogue shown in fig. 7.

In this case, two generators or pumps, G^1, G^2, circulate the water in the system, the upper outside pipe representing the

* *Scientific American.*

† For access to the record of this case we are indebted to Mr. R. N. Dyer, attorney for the prosecution.

positive conductor, the lower pipe representing the negative conductor, and the central pipe the neutral conductor. Upon each side of the neutral pipe, and communicating with the outside pipes, are motors corresponding to the lamps in the electric circuit. So long as the quantity of water consumed by the motors on both sides of the central pipe remains the same, the water circulates by passing forward through the upper pipe, through the motors, and transversely through the neutral pipe, and returning by the lower pipe; but so soon as the equilibrium is disturbed by shutting off one or more of the motors on one side of the system, the water which would have been required to run that motor must return to the pumps through the neutral pipe, or be forced outward through the neutral pipe, according as the positive or negative current is shut off.

The Edison company hold that the three-wire system effects a theoretical saving of 62½ per cent. and an actual saving, due to the use of smaller neutral conductors in the feeding portions of the system, of at least 75 per cent. in the cost of conductors. The conductors formerly represented the largest item in the cost of the completed plant.

The value of the invention is shown by the fact that almost immediately after the introduction of the three-wire system the electric lighting business increased enormously, and electric lighting was placed on a basis which enabled it to compete successfully with gas at the lowest price.

ELECTRIC LIGHT AND GAS.

By Ed. C. DE SEGUNDO, Assoc. M.Inst.C.E.

"COMPARISONS," the time-honoured adage would have us believe, "are odious." On the other hand, we are confronted by the incontrovertible assumption that, as our knowledge is purely relative, the additions to our stock of knowledge, or, in other words, every advance in science is brought about and verified by comparisons. Can we argue, therefore, that advances in science are odious? There is obviously a flaw in the syllogism, and on a little consideration we find it as clear as the error in the false syllogism quoted in elementary text-books of logic :—

Feathers are light,
Light is contrary to darkness,
Therefore
Feathers are contrary to darkness.

Here the word light is used in two different senses; above, the word comparison may be taken to be used in equally different senses.

There is all the difference between a comparison between two things referred to a third, which is an acknowledged standard, and a comparison between two things referred to each other. These two comparisons may be distinguished by calling the first an absolute comparison, and the second a relative comparison. Of course, the expression absolute applied to a comparison is as accurate, or, rather, as inaccurate, as when applied to a system of units; but it will serve as a distinction.

The proverb quoted at the commencement of this article refers to relative comparisons, while the comparisons which form the basis of any extension of our physical knowledge are of the class we have just distinguished, for want of a better word, by "absolute." It is obvious that in comparing two things, one with another, you may be attempting the impossible; the two things may not be comparable one with another. Clearly, then, any attempt to deduce a sequence of thought which may result in a logical conclusion of any utility would lead to a discussion which would soon take the form of a series of gratuitous assertions and baseless arguments, ending in a hopeless difference of opinion, if not in a breach of the peace.

A comparison, if it is to serve any useful purpose, must be absolutely impartial and disinterested. There must be no suspicion of wishing to prove the superiority of one or other of the things in question, otherwise the title "comparison" becomes a misnomer. Again, a true comparison should include an unbiassed discussion of the merits and demerits of the respective things on every count, and not only in one particular direction. It would be absurd to compare iron ore with a fruit as to their relative powers of sustaining life, because they both come out of the earth, and to reject iron as altogether useless. If investigation be carried a little further than the mere surface of the question, it is found that iron ore becomes an exceedingly potent factor in regard to sustaining life by enabling such tools to be made as render possible the cultivation of fruits and vegetables on a scale which would be impossible without it.

A matter engrossing public as well as technical interest at the present time, is the relative merit of electricity and gas as illuminating agents.

The "comparison" has been effected by many different authorities in as many different ways, and even when a relative basis of comparison, namely, "light for light," is agreed upon, it is found that the whole matter turns upon the efficiency of the means of producing light. The gas advocates maintain that if proper burners are used 5 cubic feet of gas per hour will produce a light of 16 to 20 candle-power in intensity, whereas, the electric lamp, though nominally of 8 or 16 C.P., really gives 6 or 13, respectively, when the average performance, extending over the life of the lamp, is taken into account, owing to the molecular disintegration and consequent coating of the glass bulb due to the passage of the current through the filament of the incandescent lamp.

Advocates of the electric light, on the other hand, conscious of their being tied hand and foot by "patents," and of their inability—at least in England—to improve the manufacture of the incandescent lamp, attack the gas burner, and say that the *average* gas burner, as used in everyday practice, yields but 2 to 2½ candles per foot of gas.

But is this not comparing the performance of the best electric burner with a bad gas burner? and is this fair? What do electricians say when gas engineers compare the argand burners with the ordinary electric burner? and what would they say if gas engineers were to issue a comparison between the performance of an argand burner and an electric lamp which was known to be taking 10 watts per candle, but which was used because it was one-quarter the price of the efficient burner?

If consumers were willing to spend as much on their gas burners as they do on their electric burners, the question of the relative cost of electricity and gas on the basis of light for light would, in a week, be for ever set at rest.

It is extremely improbable that any electric lamp will be devised on the filament principle which will take less than 2 watts per candle in 8 and 16 C.P. sizes. It is also improbable that the profitable sale of electrical energy, per unit, registered on consumers' meters will ever, except in special instances, sink, in the case of a supply company, below 4d. per unit. Under these conditions we should have

$$3{,}200 \text{ C.P.} = \begin{matrix} 1{,}000 \text{ cub. ft. gas} = 3\text{s.} \\ 6{,}400 \text{ watts} = 2\text{s. } 1\tfrac{1}{2}\text{d.} \end{matrix} \left(\begin{matrix}\text{Average price} \\ \text{in England.}\end{matrix}\right)$$

which is in favour of electricity. But who shall say that by the time electrical engineers have realised these conditions, gas engineers will not have improved their gas and their burners so that 5 cubic feet per hour will not yield, for instance, 75 candles, or more?

The attempt to show the superiority of electricity on the basis of light for light over gas, must be relegated to the category of comparisons that are odious, as long as any really useful knowledge is expected to be gained by it.

There is no harm, however, in glancing at things as they are, and working out the price at which electricity should be sold in order to compete with—not *gas*, but the manner in which gas is ordinarily used in London and elsewhere, light for light. Let us assume that the average burner yields 2½ candles per foot.

Edison-Swan lamps (English manufacture) take 3¾ watts per candle (average performance during 1,000 hours). See ELECTRICAL REVIEW, October 31st, 1892.

We then have :—

16 C.P. is obtained by gas for $\frac{16}{2{\cdot}5} = 6{\cdot}4$ cubic feet during one hour.

16 C.P. is obtained by electricity $3{\cdot}75 \times 16 = 60$ watts during one hour;

but the average gas burner costs 2d. to 6d., say 4d., and the electric burner costs 3s. 9d. (present price).

An average gas burner lasts as long as an electric one, and this is a very fair assumption for electricity.

Thus, the cost of lighting by gas and electricity over a period equal to the life of a 16 C.P. incandescent lamp for an equal candle-power, say, 16 C.P. for 1,000 hours, would be :—

Cost of 6,400 cubic feet delivered + 6d. (*a*)
„ 60,000 watts delivered + 45d. (*b*)

Put gas at 3s. per 1,000,
Watts at 6d. per 1,000.

$$a = 230{\cdot}4\text{d.} + 6\text{d.} = 236{\cdot}4\text{d.}$$
$$b = 360{\cdot}0\text{d.} + 45\text{d.} = 405\text{d.}$$

and electricity is

$$\frac{(405{\cdot}0 - 236{\cdot}4)\ 100}{236{\cdot}4} = \frac{168{\cdot}6 \times 100}{236{\cdot}4} = 71{\cdot}3 \text{ per cent.}$$

dearer than gas, light for light, at the present day. Taking into consideration that within the next year we shall probably have lamps taking $2\frac{3}{4}$ watts per candle, and costing 1s. 6d., the figures for electricity would be altered as follows :—

$$360 \times \frac{2{\cdot}75}{3{\cdot}75} = 304{\cdot}6 + 18 = 322{\cdot}6$$

and the percentage of excess would be reduced to

$$\left(\frac{322{\cdot}6 - 236{\cdot}4}{236{\cdot}4}\right) 100 = 36{\cdot}5 \text{ per cent}$$

The foregoing shows that in fairness and truth it is absurd for electricity to attempt to compete with gas, light for light, more especially when it is remembered that the illumination is effected in one case by a luminous filament, and in the other by a sheet of burning gas.

But, in spite of all this, the demand for the electric light is growing by leaps and bounds, as is amply testified to by the balance-sheets of the Electric Supply Companies in London and elsewhere. It must, therefore, be true, that very considerable counter-balancing advantages and attractions must attach to the application of electricity to lighting purposes, which, when taken into consideration, constitute a source of economy either in money or in kind.

(To be continued.)

CONDITIONS FOR THE ELECTRIC LIGHT IN THE CITY OF SANTIAGO (CHILI).*

THE Municipal Council in its meeting of August 5th, 1892, resolved to invite a public competition for the installation of the electric light on the following conditions :—

1. The lowest number of lamps to be put up is 2,000 glow-lights and 50 arc-lights. Tenderers have to fix the intensity and the price for each glow and arc-light. Different intensities of current may be stated with corresponding prices.

The municipal council may increase the number of the glow and arc lamps at pleasure without altering the price of the unit.

2. The distribution and the locality of the lamp will be determined by the local authority.

3. The pillars or brackets which support the lamps must be of iron, and must be executed according to patterns submitted by the tenderer.

4. The lamps must burn from sunset to sunrise ; the hours at which the lamps are lighted and extinguished are to be fixed in the contract according to the season of the year.

5. The tenderer binds himself to pay a penalty for every hour during which a lamp does not act. The penalty is per glow-lamp and per hour 10 centaves, and per arc lamp 1 piastre.

6. The leads must lie underground and the municipal authorities have to determine their situation.

7. The price must be calculated at the fixed rate of 24 pence per piastre. The city binds itself to credit the tenderer with the difference of prices if the course is lower than the above. The tenderer is bound to credit the city similarly if the course is higher.

8. The municipal authority pays the tenderer for the monthly consumption between the 1st and the 10th of each month. The rate of exchange shall be that fixed on the first of each month by a bank named in the contract.

9. The tenderers must name the interval within which the works must begin, and that within which they must be completed. The outside limit for the commencement is one year, and for the completion at the utmost two years.

10. The tenderers must accompany their proposal with a deposit note of 20,000 piastres, payable at sight to the municipal council.

The tenderer who obtains the concession must allow this deposit to remain as security. It is forfeited to the council if the tenderer does not, within a month after receiving the concession, sign the notarial document, or if he does not fulfil the above limits of time for beginning and completing the works.

11. For the purposes of the contract the municipal council places the streets and squares at the disposal of the contractor for a term of 10 years, beginning with the day fixed for the completion of the installation.

12. Every dispute which may arise between the representatives of the city and the holder of the concession will be decided by the civil judge without appeal.

13 The tenders will be opened in Santiago on March 1st, 1893, at 1 p.m. by a commission of the municipal council.

14. The municipal council reserves to itself the right of rejecting all the tenders.

* *Vossische Zeitung.*

THE LIFE AND INVENTIONS OF EDISON.

No sooner is a man acknowledged a genius than the world proclaims him a hero, and is never content with his *ideas* till something has been learned of his *history*. Little wonder, therefore, that the story of Edison's life finds a place among the records of his inventions.

A series of articles by Messrs. A. and W. K. L. Dickson, in *Cassier's Magazine*, gives a most interesting *résumé* of the history and discoveries of this distinguished American. Telling, first of all, how he comes to be a happy blending of the Teutonic with the Celtic race. His family were of Dutch origin, and emigrated to America in 1730. In Edison's own way of putting it, he says : "Well ! let's see. They were millers on the Zuyder Zee, way back. My great-great grandfather was born in Amsterdam, and the rest of the family, I guess, were all right." His mother is of Scottish parentage, and to her rare abilities as a teacher, Edison seems to have owed the early impetus which he has followed up so well.

Edison is held to be essentially a self-taught man, and to this, no doubt, is due his originality of thought. His early reading was of the mixed sort, and his biographers, who, of course, could not be guilty of romancing, say that at the age of 12 he was wading through such tomes as Burton's "Anatomy of Melancholy" and Gibbon's "Decline and Fall of the Roman Empire." It would be indeed remarkable if Edison could trace how he came by this latter book. It is possible that a clue might thus be found to his relationship with the "Boffins," who lived "over Maiden Lane way—out Holloway direction," and have used no other, save an occasional "drop into poetry," for preparations in literature and as a substitute for "shovelling and sifting at alphabeds and grammar books," since Silas Wegg first introduced it to their distinguished ancestor in the "bower."

We next find Edison studying Newton, but it was not a success. "Mystified by the obscure and technical language of the 'Principia,' he resorted to outside assistance, and received from the lips of a comparatively uneducated man such a simple and satisfactory explanation as to confirm him in his intolerance of mathematics as a basis of scientific instruction. This man explained the problem to him by the use of very simple language and without the employment of mathematics. He at once came to the conclusion that Newton could have dispensed his knowledge in a much wider field had he known less about figures. It gave him a distaste for mathematics from which he has never recovered." In future, therefore, we must regard mathematics as a kind of disease peculiar to scientific men, which they contract at about middle age, and hand down to their followers.

Physically and mentally Edison has remarkable energy ; he is able to do a great amount of work with little need of

rest. Everybody knows about him, and has heard how he developed from a vendor of news to a maker of it; his mind and body ever active. And, like the fœrie knight, he seems to have been as brave as he was good. The story is told of how he rescued the three-year-old child which was forming a short-circuit to the railway lines just as an express locomotive was about to close its little history. The biographers end the story thus:—"To dash himself in front of the impending peril, to seize the child in his strong young arms, and to fling himself into by-ways of safety, was a work almost as instantaneous as the action of *his own beloved fluid*." We do not know what his "own beloved fluid" is, but we "guess it is all right."

The life of this distinguished inventor helps us to a better understanding of "that spark from central divinity which men call 'genius.'" And it leads us to the conclusion that not everything depends upon the spark, but that a great deal can be done by the "blowing." Genius is not altogether a happy fatality, but is something which may, to some extent at least, be cultivated, if energy is rightly applied. That is an excellent definition of "genius" which describes it as "an infinite capacity for taking pains;" this places it on a practical basis, and gives everyone equal right and possibility of success.

COMMUNICATIONS FROM AUSTRIA-HUNGARY.

[FROM OUR OWN CORRESPONDENT.]

THE Vienna Tramway Company purpose introducing electric working on their lines, and have already taken all the necessary preliminary steps. In Government circles the introduction of electric working has long been desired on the radial lines, *i.e.*, the lines which lead to the former suburbs of Vienna which are now united to the capital. The Tramway Company are also contemplating the introduction of electric working on the ring line. It is thought that in this manner the question of the overcrowding of the tramcars may be solved; as a much more rapid intercourse may be effected with electric power than with animal traction.

In Austria and Hungary electric traffic is now very energetically pushed forward to facilitate intercourse to and in the watering places. At present the owner of the Giesshübel baths, Herr von Mattoni, is planning an electric line from Giesshübel to Karlsbad, whilst the town of Karlsbad itself is intending to lay an electric line from the interior of the city to the railway station. In Hungary an electric railway is now being built from the town Szabadka to the watering place Palics, whilst the Hungarian Ministry of Agriculture is constructing a line from the celebrated watering place Herkulesfürdo (the property of the Government) to the railway station. Further, in the ensuing years extensive electric mining lines will be constructed in richly-wooded Upper Hungary.

The commission for lighting the city of Buda-Pesth, has already completed the consideration of the agreement for the two electric works which are to receive concessions. In the beginning of January, 1893, the negotiations for the definitive agreements with the concessionaries (the Gas Company and Ganz & Co.) are to commence. According to the agreement to be concluded, both undertakings are bound to produce the alternating current at the electrical works themselves. The gas company will fulfil this requirement by means of a mono or polyphase alternating current in order to actuate alternating current continuous current transformers at the sub-stations which are to charge the accumulators. Ganz & Co. effect the distribution of energy by means of alternating current transformers. In the meantime the gas company is considering the introduction of Auer's gas-glow light.

The provincial capital Lemberg projects the arrangement of municipal electric works in combination with the construction of an electric railway. The work in connection with this undertaking will be given out in the course of 1893 by means of an international competition.

The capital of Bohemia (Prague), which is the proprietor of the local gas works is planning the erection of municipal electric works, and has already invited several large firms to participate in the competition. It is not yet decided whether only small works are to be erected for the supply of a limited district of the town with a direct distribution of the current, or large works to supply the whole of Prague.

In Vienna an agitation in reaction against Auer's gas-glow light has commenced among the consumers. Concerning this agitation the Vienna Press gives the following particulars:—

The Auer Gas-Glow Light.

"As we learn there has been formed a combination of the consumers of the well-known Auer gas-glow light for the purpose of making an energetic protest against the proceedings of the patentees, Dr. Auer von Welsbach and Williams. The consumers, at the head of whom stand a number of the most eminent proprietors of the cafés, are dissatisfied with a number of defects in the manner in which they are treated by the gas-glowlight firm. We are in receipt of the following communication:—

"'Mr. Editor,—In consequence of the appearance in yesterday's number of your esteemed paper of a notice on *The Auer Gas-Glowlight*, I hasten to inform you that I and my colleague, Dr. Moriz Singer, have much pleasure in associating ourselves with the protest-combination of the consumers of the Auer gas-glowlight. The great and undeniable advantages which the Auer gas-glowlight presents are chiefly outweighed or indeed rendered illusory, by the frequent changes which have become necessary, especially of late. The cylinders are evidently of a quite miserable character. I learn from a practical quarter that Messrs. Welsbach and Williams procure simply refrigerated glasses, as doubly refrigerated glasses are more expensive. Whether this takes place I cannot examine, since the bursting cylinder always ruins the ignited substance. The fact is that the cylinders often fly in pieces in an explosive manner, without any outward occasion, often a considerable time after they have been extinguished, and thus all the economy in the consumption of gas disappears in a few hours, not to speak of the annoyance, the unpleasantness and the trouble of sending to the Schleimüllgasse and the exceedingly contemptuous manner with which the most justifiable complaints are received at the head office.

"'Dr. FRUHWALD.'"

ALTERNATING CURRENTS AND THE DIVIDED CIRCUIT.

BY ARTHUR WHITWELL, M.A.

THE total or equivalent impedance of a divided circuit, the resistance, self-induction and impedance of the branches being r_1 r_2, &c., L_1 L_2, &c., α β, &c., was given in the ELECTRICAL REVIEW for December 2nd, 1892, and is

$$\frac{1}{\sqrt{\left(\varepsilon \frac{r_1}{a^2}\right)^2 + \left(\varepsilon \frac{p L_1}{a^2}\right)^2}}$$

In the simplest case, in which there are only two branches, this expression may be reduced to $= \frac{\alpha \beta}{\omega}$

where $\alpha = \sqrt{r_1^2 + p^2 L_1^2}$, $\beta = \sqrt{r_2^2 + p^2 L_2^2}$,

and $\omega = \sqrt{(r_1 + r_2)^2 + p^2 (L_1 + L_2)^2}$,

that is, we may say that the equivalent impedance of two conductors in parallel is equal to the product of their impedances, taken singly, divided by their impedance when in series. If in the above expression we substitute resistance for impedance, we get the analogous expression for the equivalent resistance of two conductors in parallel when the currents are direct, viz., $\frac{r_1 r_2}{r_1 + r_2}$.

To find the fraction of the total current which flows in one branch of a simple divided circuit when the currents are

all direct, we divide the total resistance by the resistance of that branch. Thus a current, C, will divide in the proportion $\frac{C\,r_1}{r_1 + r_2}$ in the r_2 branch, and $\frac{C\,r_2}{r_1 + r_2}$ in the r_1 branch.

Similarly in the case of alternating currents, if the maximum value of the total current is C, the maximum values in r_1 and r_2 branches will be $C\,\frac{I}{\alpha}$ and $C\,\frac{I}{\beta}$, I being the equivalent impedance, and α, β, the impedances of the branches.

This may be shown as follows: The maximum value of the total current $C = E\sqrt{\left(\frac{r_1}{\alpha^2} + \frac{r_2}{\beta^2}\right)^2 + \left(\frac{p\,L_1}{\alpha^2} + \frac{p\,L_2}{\beta^2}\right)}$ (see the before mentioned paper). The fraction

$$\frac{I}{\alpha} = \frac{1}{\sqrt{r_1^2 + p^2 L_1^2}\sqrt{\left(\frac{r_1}{\alpha^2} + \frac{r_2}{\beta^2}\right)^2 + \left(\frac{p\,L_1}{\alpha^2} + \frac{p\,L_2}{\beta^2}\right)^2}}$$

and the products, $C\,\frac{I}{\alpha}$, $C\,\frac{I}{\beta}$, are

$$\frac{E}{\sqrt{r_1^2 + p^2 L_1^2}} \text{ and } \frac{E}{\sqrt{r_2^2 + p^2 L_2^2}},$$

and these are the maximum values of the currents in the r_1 and r_2 branches, respectively.

With the object of shewing at a glance how the currents, impedances, angles of lag, and watts, in a simple divided circuit vary when the period of alternation or the resistance or self-induction of one of the branches varies, I have plotted three sets of curves.

In fig. 1, r_1 varies, $L_1 = \cdot 03$ henries, $r_2 = 10$ ohms, $L_2 = \cdot 03$ henries, $p = \frac{2\pi}{T} = 500$, $E = 100$ volts. Curve 1 is a straight line, and represents the current in r_2; 2, total

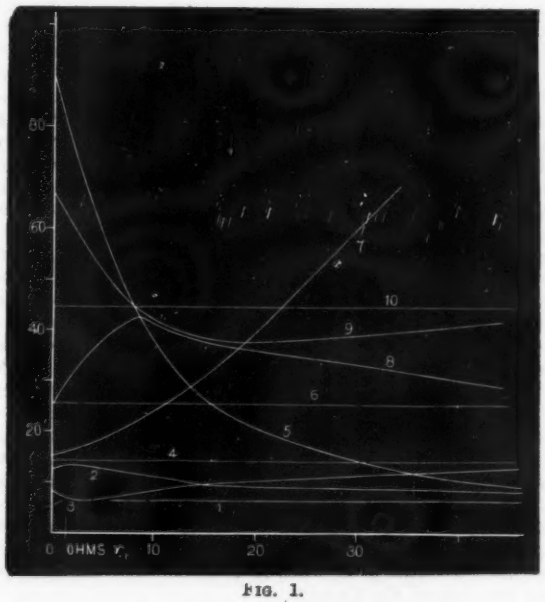

FIG. 1.

current; 3, equivalent impedance; 4, impedance of r_2; 5, lag of current in r_1, behind impressed E.M.F.; 6, watts in r_2; 7, impedance, of r_1 branch; 8, total watts, or if the ordinates are measured from 6, it represents watts in r_1; 9, angle of lag of total current behind impressed E.M.F.; 10, ditto, for current in r_2. The horizontal divisions represent 10 ohms, the vertical divisions represent 10 ohms for curves 3, 4, 7 (impedances); 10 amperes for curves 1 and 2 (currents); 10 degrees for curves 5, 9 and 10 (angles of lag), and 100 watts for curves 6 and 8.

Curve No. 3 has a minimum value when $r_1 = 4{\cdot}1$ ohms, so that from $r_1 = 0$ to $r_1 = 4{\cdot}1$, the equivalent impedance, is *diminishing*, although we are adding resistance to one of the branches. The value of r_1 at the minimum

$$= \sqrt{p^2 L_1^2 + a_2} - a$$

where $a = \frac{r_2^2 + p^2 L_2^2 + 2\,p^2 L_1 L_2}{2\,r_2}$.

The straight line, 4, is an asymptote to the curve, 3; that is the total impedance approaches the value of the impedance in r_2, when r_1 appoaches ∞.

The total current, curve 2, has a maximum, where 3 is a minimum it crosses 3 at the point where the ordinates of the curves each = 10 and approaches its asymptote 1 (current in r_2).

5. When $r_1 = 0$ the lag in r_1 is 90° it rapidly falls, and when $r_1 = p\,L_1$ its value is 45°. The axis of x is an asymptote to this curve.

6. The watts expended in r_2 are of course constant, the curve is a straight line, the ordinates all = 2,500.

7. The curve showing the variation of the impedance in the r_1 branch is a rectangular hyperbola, the asymptote being at 45° to the axes.

8. The total watts curve at first rapidly rises and has a maximum value of 4,160 at the point $r_1 = p\,L_1 = 15$, after this it slowly drops and approaches its asymptote 6. The watts in r_1 are represented by 8, if 6 is the zero line, they vary, of course, similarly to the total watts the maximum value being 1,660, and the value at r_1 = infinity being 0.

9. The angle of lag of total current behind impressed E.M.F. when $r_1 = 0$ is 66° ·47′ it rapidly diminishes, becomes a minimum when $r_1 = 42{\cdot}3$ ohms and approach 45° at infinity. The minimum value occurs when

$$r_1 = p\,L_1 + \sqrt{\left(\frac{L_1}{L_2}\left(r_1^2 + p^2 L_2^2\right) + 2\,p^2 L_1^2\right)}.$$

10. The lag in r_2 is always 45°. It will be seen that all the lag curves pass through the point $r_1 = 15$ and 45°.

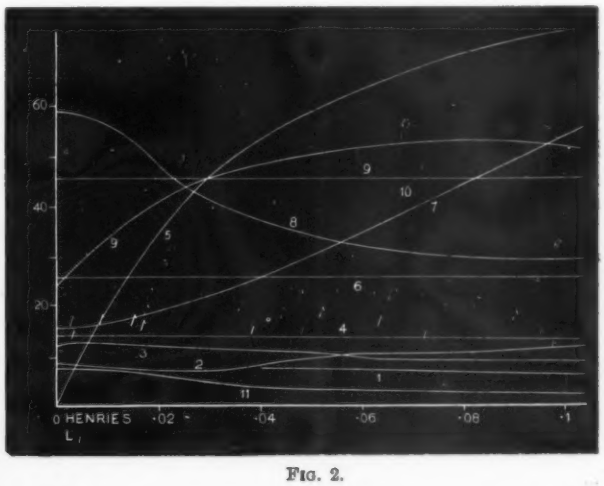

FIG. 2.

In fig. 2 the curves are numbered as in fig 1, but the resistance of r_1 is 15 ohms and L_1 varies, the other quantities remaining the same. Each horizontal division represents ·02 henries. Curves 2 and 3 are similar to the corresponding ones in fig. 1. The total impedance diminishes as L_1 is increased from 0 to ·008 henries, after the minimum it gradually approaches its asymptote 4 (impedance in r_2). Curve 8 shows that the total watts are a maximum when $L_1 = 0$. The curve differs very materially from the corresponding one in fig. 1. Curve 7 represents impedance in r_1, it is a hyperbola but not rectangular. 9. The angle of lag of total current behind impressed E.M.F. is 23° 11′ when $L_1 = 0$, r attains a maximum of 51°—52°, when $L_1 = \cdot 0847$ henries, it then gradually diminishes and approaches 45°. 5. The lag in r_1 begins at 0° and approaches 90°, when r_1 approaches infinity. The curves 5 in figs. 1 and 2 are similar, but reversed, as might have been anticipated from the expression $\frac{p\,L_1}{r_1}$, which is the tangent of the angle. The three lag curves meet in the point $L_1 = \cdot 03$ henries, 45°, simply because of the values taken for r_1, r_2, L_1, L_2; they do not necessarily meet in one point.

In fig. 3, $r_1 = 15$ ohms, $r_2 = 10$ ohms, $L_1 = \cdot 03$ henries, $l_2 = \cdot 02$ henries, and $p = \frac{2\pi}{T}$ varies. Each horizontal divi-

sion represents 500, or an increase in the number of alternations of $\frac{500}{2\pi}$ per second.

The total impedance, curve 3, never diminishes as in figs. 1 and 2, when $p = 0$, its ordinate = 6 ohms. The total current curve commences at 16·6, when $p = 0$. 7. The impedance curve for r_1 is a hyperbola; it commences at 15 ohms, when $p = 0$, its asymptote is dotted in. Curve 11 is the current in r_1. The current and impedance curves for r_1 and r_2 would be similar to 11 and 7, and are not drawn. Curves 12 and 6 show the variation of the watts in r_1 and r_2, and 8 the total watts. They are a maximum when $p = 0$, they diminish slowly from $p = 0$ to $p = 100$, then very rapidly until p = about 800, and then more slowly approaches zero when p approaches infinity. 5 and 9 show the lag in r_1 and the total lag, they do not differ very much for any value of p.

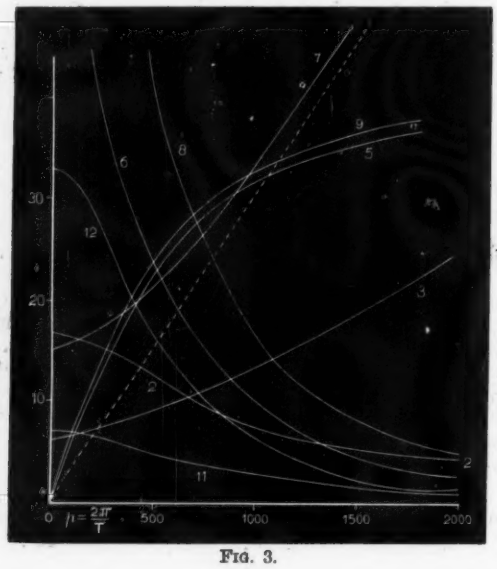

FIG. 3.

EXPERIMENTS WITH HIGH FREQUENCY ELECTRIC DISCHARGES.

BY A. A. CAMPBELL SWINTON.

THE author has succeeded in passing through his body, from hand to hand, sufficient electricity to bring the filament of an ordinary 5 candle-power 100-volt incandescent lamp very nearly to full incandescence, or to bring the filament of a 32 candle-power 100-volt lamp to full redness. Practically no sensation was experienced.

The apparatus employed consisted of a large "Apps" induction coil, capable of giving 10-inch sparks, supplied with current through the ordinary vibrating contact breaker, and a resistance consisting of eight 50 candle-power lamps in parallel, from a 105-volt continuous current supply. The positive and negative terminals of the secondary of the induction coil were connected respectively to the inside and outside coatings of three half-gallon Leyden jars, connected in parallel. The disruptive discharge of these jars across an air gap of about a quarter of an inch excited the primary of a simple form of high frequency coil similar to those employed by Mr. Tesla and Prof. Elihu Thomson. The secondary of this coil consisted of 500 turns of No. 26 S.W.G. cotton covered wire wound on a paper tube. Outside this paper tube was a glass tube, upon which the primary, consisting of 10 turns of three No. 16 gutta-percha covered wires in parallel, were wound. The whole coil was immersed in resin oil contained in a wooden trough. The ends of the secondary were connected through small glass tubes, also filled with oil, to brass balls.

On approaching the hand to one of the balls forming the terminal of the oil coil, sparks shoot out from the brush discharge which surrounds it. If the spark is taken on the skin a sharp prick is felt, but on approaching the terminal or touching it with a piece of metal grasped in the hand, or after grasping the terminal itself, practically no appreciable sensation is felt. If the terminal is grasped in this manner with the right hand, sparks will shoot out from the left hand, or indeed from any portion of the body, if brought into proximity with another person, a piece of metal, the gas or water pipes or any conducting body. In the experiments referred to, the incandescent lamp was hung by one terminal on a wire connected to earth, and connection was made between the other lamp terminal and the coil, through the two arms and body, by the right hand being brought into contact with one terminal of the oil coil, and a piece of metal grasped in the left hand being approached to the free terminal of the lamp. At the first approach the bulb of the lamp became filled with phosphorescent light, but on reducing the distance between the metal in the left hand and the free lamp terminal, sparks shot out between them, and the filament at once became incandescent, the incandescence increasing very nearly to the full normal amount when the piece of metal and the lamp terminal were finally brought into contact.

To produce a similar incandescence of the filament with continuous or alternating currents of ordinary frequency would require about one-fifth of an ampére, and, at first sight, it would seem that this quantity of current must pass through the arms and body of the operator.

It has been generally assumed that with high frequency currents the current is rendered harmless by reason of the high frequency: in fact, that high frequency renders harmless to the human body currents of a strength that would be dangerous and painful, if not fatal, were the frequency lower. The author is inclined to think that another explanation is possible, and that the true fact is, not that high frequency renders harmless a given strength of current that with ordinary frequency would be harmful, but that with high frequency it is possible to obtain effects with exceedingly small currents, that with continuous and ordinary alternating currents can only be obtained by the use of much larger currents.

This hypothesis is probably applicable to many other high frequency effects, but as applied to the above-mentioned experiment it is simply this: The lamp filament having a certain definite resistance, with continuous or ordinary alternating currents which pass uniformly or nearly so through the section of the filament, a certain ampérage of current is necessary to produce the number of watts required to raise the filament to incandescence. With the high frequency currents, on the other hand, as is well understood, the current travels chiefly on the outer surface of the filament, little or none passing through the central portion. The current is, in fact, merely skin deep. The virtual resistance is therefore very high, as only an extremely small portion of the sectional area of the filament acts as a conductor. There is an ample sufficiency of volts, and though the current is very minute, there is a sufficient expenditure of watts to raise the filament to incandescence. The lamp, in fact, ceases to be a 100-volt lamp and becomes, it may well be a 100,000-volt lamp. As confirming this hypothesis it should be mentioned that while the filament was incandescent, sparks passed between the lamp terminals, which were at some distance apart, this being evidence that there was a difference of potential amounting, at least, to thousands of volts between the two ends of the filament.

Returning to the experiments, several other curious results were obtained. If, instead of connecting the lamp to the coil through the human frame, a wire was used, the filament became much brighter than in the previous experiment. In fact, it gave considerably above its normal candle-power. From this it was evident that the human body offered considerable opposition of some description to the passage of the electricity. In order to form some idea of the amount of the opposition, the body was again inserted in the circuit between the coil and the lamp as previously, and the thumbs of the two hands brought near together. Sparks about one-quarter of an inch in length were found to pass between them, evidencing that the two hands of the operator had a difference of potential between them apparently equal to some thousands of volts. When the sparks passed between the hands, or when the wrists were brought into contact so, as it were, to short circuit to some extent the resistance of the

arms and the body, the filament became very appreciably brighter. It should be mentioned that when sparks were allowed to pass between the hands very perceptible shocks were felt in the wrists.

Another experiment was to connect one lamp terminal by a wire to the coil, connect the other lamp terminal to earth, and short circuit the lamp through the body by grasping the coil terminal with one hand and a piece of metal connected to earth with the other. The effect of so doing was to reduce the incandescence of the filament to rather less than one-half its normal amount, half of the available current going apparently through the lamp, the other half through the body.

With the lamp terminal connected to the coil, it was found unnecessary to connect the other lamp terminal to earth to produce incandescence, all that was necessary being to touch this lamp terminal with a piece of metal held in the hand. That the incandescence of the filament produced under these conditions was due to the electrostatic capacity of the operator, and not to his forming a connection to earth, was evidenced by the fact that it made no perceptible difference whether he stood on the floor or on an insulated stool.

In all the above experiments the second terminal of the oil coil was free, and not connected to anything. It was, however, found that the effect of a second operator touching this terminal, or of connecting it by wire to earth, was to diminish the incandescence of the lamp filament. It was also found that the filament incandesced to a greater degree of brightness when connected as above between one terminal of the coil and earth, than when it was directly connected between the two terminals of the coil. This seems to show that capacity has much to do with the results obtained.

It should also be mentioned that in some of the experiments there was a decided tendency for the filament to vibrate in unison with the contact breaker of the induction coil. In fact, in some cases the amplitude of vibration was sufficient to cause the end of the filament to beat against the glass of the lamp bulb.

Estimation of Lead by Electrolysis.—A new method, possessing an interesting bearing upon electrolysis, has just been proposed by L. Medicus, for the estimation of lead. It is described in the *Berichte*, Vol. 95, pp. 2,490—92, but may be stated briefly as follows:—Lead may be estimated in alkaline solution free from chlorides by precipitation as oxalate, which, after washing, is dissolved in nitric acid and converted into lead peroxide by electrolysis. In the presence of chlorides, however, the precipitation of the oxalate is incomplete, and the method is therefore not available for determining the amount of lead in galena, after dissolving the mineral in hydrochloric acid; in this case the lead chloride is dissolved in potash, carbonic acid gas is passed through the solution for two hours, and the precipitated carbonate is dissolved in nitric acid and then electrolysed. The analytical data given in the paper show that the method is capable of giving trustworthy results.

The India-rubber Outlook in Nicaragua.—It would be difficult to beat the Nicaraguans for improvidence. To talk of "killing the goose that lays the golden egg" only half expresses their practice in the getting of rubber. The man who killed his goose at least had the eggs to fall back upon. Rubber is procured in Nicaragua by felling the trees, thus taking no care of the future whatever. Consequently, the yearly output of this valuable substance from Nicaragua is steadily decreasing. The Government attempts no supervision of the forests; anyone may cut down the trees and great destruction is caused by the saplings being cut down as well as the mature trees. Yet it cannot be that the gutta tree cannot be cultivated in Nicaragua as well as elsewhere; in the district of Managua there are large tracts of land that could readily be thus utilised. There can be no question that if it be profitable to plant tracts of land with coffee, oranges, &c., and wait years for the crop, that the financial return from a rubber crop would not well repay the enterprising planters who turned their attention to it.

PROVISIONAL ORDERS.

THE following is a list of applications for Provisional Orders deposited with the Board of Trade, on or before December 21st, 1892, under the provisons of the Electric Lighting Acts, 1882 to 1890.

Title of order and description of area.	Name of promoters.	Agents.
Altrincham and Bowden Electric Lighting Order. The Local Board Districts of Altrincham and Bowdon, and a portion of the district of the Rural Sanitary Authority for the Altrincham Union.	Manchester Edison Swan Company, Limited.	Messrs. Lewin, Gregory and Anderson, 13, King Street, Whitehall, S.W.
Barnet Local Board Electric Lighting Order. The District of the Local Board.	The Local Board.	H. W. Poole, Esq., solicitor, Barnet.
Beckenham Electric Lighting Order. A portion of the Parish of Beckenham.	Do.	F. Stevens, Esq., Clerk to the Local Board, Beckenham.
Bridgend Electric Lighting Order. The Urban Sanitary District of Bridgend.	Do.	C. E. Baker, Esq., 22, Great George St., Westminster. S.W.
Brighton Electric Supply Order. The Municipal Borough of Brighton.	Brighton and Hove Electric Light Co., Limited.	Messrs. Wyatt and Co., 28, Parliament Street, S.W.
Colchester Electric Lighting Order. The Borough of Colchester.	Corporation.	Messrs. Dyson and Co., 24, Parliament St., Westminster, S.W.
Eccles Electric Lighting Order. The Municipal Borough of Eccles.	Do.	C. E. Baker, Esq., 22, Great George Street, S.W.
THE COUNTY OF LONDON.		
Hackney Electric Lighting Order. The District of the Board of Works for the Hackney District.	The Board of Works.	Richard Ellis, Esq., Town Hall, Mare Street, Hackney.
Hammersmith Electric Lighting Order. The Parish of Hammersmith.	The Vestry.	Messrs. Jordan and Son, 5, Victoria Street, S.W.
Islington Electric Lighting Order. The Parish of St. Mary, Islington.	Do.	Messrs. W. and W. M. Bell, 27, Great George Street, S.W.
Islington Electric Lighting Order. The Parish of St. Mary, Islington.	County of London Electric Lighting Co., Limited.	Sydney Morse, Esq., 4, Fenchurch Avenue, E.C.
Poplar District Electric Lighting Order. The District of the Board of Works for the Poplar District.	The Board of Works.	Messrs. Durnford and Co., 38, Parliament Street, Westminster, S.W.
St. Mary, Islington (North) Electricity Supply Order. A portion of the Parish of St. Mary, Islington.	Holloway Electricity Supply Co., Limited.	Messrs. Sherwood and Co., 7, Great George St., Westminster, S.W.
Newcastle-upon-Tyne Electric Lighting Order. The City and County of Newcastle-upon-Tyne.	Newcastle-upon-Tyne Electric Supply Company, Limited.	Messrs. Martin and Leslie, 27, Abingdon Street, Westminster, S.W.
Newmarket Electric Lighting Order. The Urban Sanitary District of Newmarket.	British Electric Light Company, Limited.	Messrs. Rees and Frere, 13, Great George St., Westminster, S.W.
Partick Electric Lighting Order. The Burgh of Partick.	The Commissioners of Police.	Messrs. Grahames, Currey and Spens, 30, Great George St., Westminster, S.W.
Reading Electric Supply Order. The Borough of Reading.	Reading Electric Supply Company, Limited.	Henry F. Kite, Esq., 11, Queen Victoria Street, E.C.
Taunton (Corporation) Electric Lighting Order. The Municipal Borough of Taunton, and a portion of the District of the Taunton Union Rural Sanitary Authority.	Corporation.	Messrs. Sharpe and Co., 9, Bridge St., Westminster, S.W.

MAP OF ENGLAND
SHEWING
ELECTRIC LIGHTING PROGRESS
IN
THE PROVINCES TO DEC. 31ST 1892
• TOWNS.
PROVISIONAL ORDER
△ WORKS IN PROGRESS
+ ALTERNATING CURRENT
O LOW PRESSURE CONTINUOUS
● HIGH PRESSURE CURRENT
BANFF
ABERDEEN
INVERNESS
KINCARDIN
FORFAR
PERTH
DUNDEE
ARGYLE
KINROSS
FIFE
STIRLING
HADDINGTON
LINLITHGOW
EDINBURGH
RENFREW
GLASGOW
LANARK
BERWICK
PEEBLES
SELKIRK
ROXBURGH
DUMFRIES
NORTHUMBERLAND
KIRKCUDBRIGHT
WIGTOWN
TYNEMOUTH
NEWCASTLE
SOUTH SHIELDS
SUNDERLAND
CUMBERLAND
DURHAM
WHITEHAVEN
WESTMORELAND
DARLINGTON
MIDDLESBROUGH
WHITBY
SOUTH STOCKTON
SCARBOROUGH
YORKSHIRE
LANCASTER
FLEETWOOD
BLACKPOOL
SOUTHPORT
LANCASHIRE
BRIDLINGTON
HULL
CHESHIRE
DERBY
LINCOLN
NOTTINGHAM
CARNARVON
DENBIGH
FLINT
ANGLESEY
SHROPSHIRE
STAFFORD
LEICESTER
RUTLAND
NORFOLK
MONTGOMERY
MERIONETH
RADNOR
CARDIGAN
WARWICK
HUNTINGDON
SUFFOLK
CARMARTHEN
HEREFORD
BEDFORD
CAMBRIDGE
BRECON
MONMOUTH
GLOUCESTER
BUCKINGHAM
ESSEX
GLAMORGAN
NEWPORT
CARDIFF
OXFORD
HERTFORD
BERKS
SOMERSET
WILTS
DEVON
HANTS
SURREY
KENT
DORSET
SUSSEX
CORNWALL

LEGAL.

NATIONAL TELEPHONE COMPANY v. GRAFF-BAKER.

High Court of Justice.—Chancery Division.

(Before Mr. Justice Kekewich.)

(*Continued from page* 15.)

THIRD DAY (*continued*).—DECEMBER 15TH.

Mr. WILLIAM HENRY MASSEY, member of the Institution of Civil Engineers, and also of the Institute of Electrical Engineers, examined by Sir RICHARD WEBSTER, said he had had to do with electric lighting and electric working in many important positions for many years. He was in the United States two years ago, and had experience of the working of the telephone there as well as in many other places besides England. He had heard the evidence of Dr. Hopkinson, Lord Kelvin, and Sir Frederick Bramwell, and agreed with as much of it as he could understand. He started for Buda Pesth to see the electrical tramway there, but having got as far as Frankfort he got what particulars he wanted and came back home. There was certainly no difficulty in applying the Buda Pesth system at Leeds.

Is there any difficulty in applying the double overhead conductor to crossings?—Naturally I should raise as many difficulties as possible, because I do not like the overhead system; but if I were obliged to adopt it I do not see any difficulty in carrying it out.

You say you object to the overhead system. Tell my Lord why.—Looked at from an English point of view, it is a horrible system. Of course, in America, it does not matter.

Mr. JUSTICE KEKEWICH: I do not know what the English point of view is.

Sir RICHARD WEBSTER: What is your objection to it from a practical point of view?—Our streets are not filled with telegraph poles and telephones and electric poles as they are in America. One pole more or less does not matter over there. There is an objection from an æsthetic point of view.

Apart from that, with a single wire overhead conductor and insulated return, have you a liability to these disturbances?—Yes, certainly. I have had experience of them for weeks in the States, and I have heard them in England also.

Are those liabilities to disturbance obviated by having a double insulated return?—I should think they would be. They are in the case of electric lighting.

If there was a discharge of the same character from electric lighting you would expect to find the same disturbance?—Yes; and I have observed so many times in England.

In the Metropolis, are the electric lighting leads allowed to be taken to earth?—No; Parliament has forbidden it.

Have you listened at the telephone at Leeds yourself?—Yes, several times, and once I could not get my message through. I pride myself that I can speak rather well on the telephone, and I may have made a few words understood to the other man, but I could not hear what he said.

Mr. JUSTICE KEKEWICH: You are rather good, you say, at speaking. Are you good at hearing?—It depends who is at the other end. I manage very well with the American voice, what I call the penny trumpet voice, the shrill squeaky voice; it is suitable for the telephone. An American voice could go through a fearful noise.

Sir RICHARD WEBSTER: Can you use secondary batteries practically for the purpose of running tramcars?—I am not a believer in the use of secondary batteries for tramcars, but I have seen them used both in America and England. I think they are very convenient things, but they are an expensive luxury.

Cross-examined by Mr. BOUSFIELD: Do you know whether the gentleman at the other end, when you spoke through the telephone at Leeds, had the penny trumpet voice which is so admirable on these occasions?—No, he had not; still he had a very pleasant voice—not a gruff voice.

We have not all of us the same idea as to what is a pleasant voice. You are the gentleman called as a witness from the æsthetic point of view, are you not?—No, I am called as a witness to speak of facts.

You do not like the overhead system?—No, I do not. I have seen so much of it that I think it is altogether wrong.

Even the plaintiffs' system with its single overhead wire you do not like?—No, I do not. I would put it underground if I could.

Are you speaking from the æsthetic point of view?—Yes.

I suppose you still more object to the two wires overhead?—Oh, yes.

And the more cumbersome structure that that involves?—Yes. I object to overhead things altogether; I think they are a nuisance and unnecessary.

Mr. JUSTICE KEKEWICH: That is rather strong.—It is, my lord.

The heavens are above us.—Everything that can should be put underground.

Mr. BOUSFIELD: You are an admirer of the culvert system. Have you seen it at work anywhere?—I have seen it at work for rope tramways, but not for electric traction purposes.

You have given your heart to it, but you have not seen it at work?—I was against it to begin with, but I am a convert to the system.

How long have you been a convert to it, since yesterday or the day before?—Oh no. I should think more than two years ago, before I knew there was such a thing as the Buda Pesth line at all.

You have not seen, then, an electric traction culvert?—No, but I have seen what is a much more difficult thing, and that is a rope tramway culvert.

Your evidence is pure theory as regards a culvert used for electric traction purposes?—A culvert is a culvert, no matter whether you put a wire rope or an electric conductor through it.

Or whether you put sewage through it?—No, provided there was proper drainage.

Have you seen secondary batteries used for tramcars in America?—Yes. In one particular case they were tried in New York, where overhead wires were not allowed.

I suppose you know that in every case they have been abandoned in America where they have been tried?—No, I do not know that, certainly. I know that overhead wires have been abandoned to a very great extent in New York—altogether for electric lighting purposes.

Sir RICHARD WEBSTER: That is the plaintiff's case, my Lord.

Mr. BOUSFIELD: I have communicated with the Solicitor-General, and we do not propose to address your Lordship before calling evidence.

Sir RICHARD WEBSTER then read extracts from the correspondence between the parties following the complaints being made as to the interference with the working of the telephones caused by the electric tramcars.

Mr. DALZELL was re-called, and, in reply to Mr. BOUSFIELD, said he should think probably all the subscribers' wires in Leeds were connected to the water-pipe system as earth.

Mr. GEORGE WOOD, superintendent of the Leeds Corporation Waterworks, was the first witness called for the defendants. Examined by Mr. DUNHAM, he produced a plan of the water pipes in the Roundhay district, and said those pipes were of cast-iron, in what was called the spigot and socket form, and were joined together by molten lead. On July 12th he made an inspection of the supply pipes at several houses in the Roundhay district, and found the return wires of the telephones connected to the service pipes, the wire being twisted round the pipes three or four times, and then soldered fast to the pipes to make a perfect connection.

Mr. WILLIAM HENRY PREECE, F.R.S., was next called, Mr Bousfield explaining that he, being a Government official, had to go to Paris at once, and was therefore called first, although not their leading expert. Examined by Mr. BOUSFIELD, Mr. Preece said he was Chief Engineer and Electrician to Her Majesty's General Post Office, President of the Institution of Electrical Engineers and a member of the Institution and Council of Civil Engineers. He had for many years had control of the electrical department of the Post Office, both of the telegraphs and telephones. With regard to telegraphs the earth return was invariably used, and they found they were not interfered with by tramways or electric light currents. A clause protecting the Post Office was inserted in the Act under which the Leeds electric tramway was run, but they had had no need to enforce it. For telephones, also, it was the invariable practice of the Post Office to adopt a metallic return. When telephones were first brought to this country, some 15 years ago, he took an immense amount of trouble to investigate the various disturbances to which telephones were subject, and he tried to separate and differentiate the various causes. He came to the conclusion that the only possible way of making a telephone work satisfactorily and clearly was to use a metallic return. The Telephone Company had never suggested to the Post Office that the telegraphs were a nuisance to them, but he knew, as a matter of fact, that the telephones were disturbed by the telegraph wires, and the fact that they were able to read messages from wires 80 feet away led to a very interesting investigation, which was still proceeding, and which was rather opening their eyes as to the distances to which disturbance could be carried. The messages referred to were messages sent upon a circuit from London to Bradford, and they were read upon some local circuit in London. There was no more delicate instrument for picking up and indicating stray vibratory currents than the telephone. Cross talk was quite common on the telephones in London but one got quite used to it, and was able to carry on a conversation without noticing it, as one would do in ordinary conversation in a room whilst other people were talking all round. There were other disturbing sounds, arising from all kinds of causes: the Metropolitan Railway; the South London Railway; the electric light currents; the earth currents; the atmospheric currents, especially when thunder was about; it was impossible, in fact, to differentiate from the sounds you heard the causes of those sounds. With a metallic circuit all those disturbances were avoided. The Post Office had between 30 and 40 exchanges in different large towns, and in all cases they had metallic returns. These exchanges were at Newcastle-on-Tyne, Sunderland, West Hartlepool, Middlesborough, Stockton, North Shields, South Shields, Tyne Dock, Jarrow, Blyth, Blaydon, Durham, Hull, Leicester, Nottingham, Hinokley, Loughborough, Manchester, Workington, Liverpool, Cardiff, Newport, Swansea, Talywain, Pontypool, Barry Dock, Tonypandy, Britton Ferry, Aberdare, Merthyr, Ebbwvale, Falmouth, Cork, Limerick, Waterford, London and Paris. The London and Paris telephone had an exchange of its own. They had never attempted to work with a circuit consisting partly of earth returns and partly of metallic returns, but he saw no electrical difficulty whatever in doing it. Hearing of the disturbances at Leeds, he looked into the matter from the Post Office point of view. He had the whole of Leeds carefully surveyed and examined, and went himself to see how far the tramway interfered with the Post Office wires. Taking the particular subscribers affected, he should say it would be a very small matter for their wires to be duplicated so that they would have complete metallic returns; but of course it might lead to other questions beyond the mere subscribers affected.

Mr. JUSTICE KEKEWICH: I should like to know that I understand it. I gather from the map and from what I have heard that the particular district with which we are dealing is what may be called a suburb of Leeds, and it is not densely populated. Supposing these conditions were changed, as they might very well be, and you had a great many houses there, side by side, in rows and squares and so on, each of which required the telephone, and you had to supply double metallic returns for every house, then it would come to a very serious matter indeed, and if it is right there it is right in a great many other places too.

Mr. BOUSFIELD (to Witness): You think it is the right thing to do everywhere?—I do, undoubtedly.

What is your view as to the course of an electric current connected to water pipes laid in the earth—I mean as regards the amount which would follow the water-pipes and the amount which would break through the earth?—That is a very difficult question indeed to answer. The behaviour of currents through the earth is very remarkable, and however perfect the earth may be between two stations connected by an earth plate the lines of current sweep around over an immense area. In Leeds itself we have found traces of conduction of these tramway currents 1,200 yards away from the tramway line, and in South Wales, where I have recently been making some experiments, we have even traced these earth currents to a distance of quite two miles from the circuit. I have been making some very interesting experiments lately down in South Wales to endeavour to communicate between the shore and the lighthouse three miles off on Fleet Holms, and it was very essential to find out where earth induction came in, and where other conduction came in. The difference between conduction and induction is the difference between the motion of the earth and the motion of the ether that gives us light. In these experiments it was shown unmistakably that the earth was affected to a distance of two miles around the circuit on which I was experimenting, and it was only when you got beyond two miles that you got into absolute effects of induction. The strength of current was 8 amperes and very few volts, 20 or 30. We were able to speak and read a message at a distance of three miles on this island, simply by the inductive effect through the air. I have been at it now for some seven or eight years, and every year more or less some fresh things crop up. The experiments are becoming very interesting, and really I think they will assume a practical form.

Mr. BOUSFIELD: Do you think the doubling of our wires and the use of a double conductor would do away with disturbance of the telephone in Leeds?—I should doubt it very much, because one of the essences of a metallic circuit is the power to twist your wire so as to always maintain the average distance between the inducing wire and the induced wire the same. You cannot do that with a double wire for tramway traction.

Apart from the tramways, what is your view about the telephone as an instrument for practical purposes in the absence of that complete metallic return?—It is an ineffective and incomplete apparatus.

Do you consider that the use of an earth return is in the long run the most economical from a monetary point of view?—I think quite the reverse. I think, myself, that if you improve your service by duplicating your wires you increase your business, and the increased business pays for the increased cost of duplicating.

Cross-examined by Sir RICHARD WEBSTER: I am aware that you are a master of expression, but you are the apostle and high priest of duplicate wires for telephones?—I am.

You have enunciated it for the last 12 or 15 years?—I have.

Never varied from it?—Never.

And have used very strong language about it?—Frequently.

Still a very large number of people, unfortunately, will not adopt your religion?—Unfortunately they will not.

I am sure they are very misguided, but we must look at things as they are. I am correct in saying, am I not, that the National Telephone Company have no monopoly against the Post Office—they cannot stop the Post Office from competing?—No.

I am a little curious to supplement the information you have given my Lord, and perhaps I shall be able to help you. Is it a fact that, in giving your evidence about telephonic exchanges, you have called a place where you have got one subscriber an exchange?—Yes.

WITNESS, in response to Sir Richard Webster's suggestion, again read through the list of Government exchanges, adding the number of subscribers at each place. It then appeared that in four places there was only one subscriber, in two places two subscribers, in two places three, and in other two places four. The highest numbers were at Newcastle-on-Tyne (612), Hull (163), and Leicester (105). The total number of telephones in use was 5,382, of which 691 were in Government offices, and 4,691 in use at Reuter's offices.

Sir RICHARD WEBSTER: Do you happen to know how many telephones there are out belonging to the National Telephone Company?—I only know from mere reading. I think it is something like 40,000 or 50,000.

You are very nearly accurate. You probably know that the Telephone Company are now paying £45,000 a year to the Government as royalties?—Certainly.

It is within your knowledge that at Plymouth the Post Office telephone was there before the National Telephone came?—It was.

Did you not establish at Plymouth an exchange on the double-wire system?—We established it at the wish of the Plymouth people, and we maintained it as long as they wanted us to maintain it.

Were the telephone company misguided enough to go down and compete with you?—They compete everywhere; they are a commercial company and we are not.

And the misguided Plymouthians actually preferred the National Telephone Company to you?—The misguided people did.

And they succeeded in obtaining on the single wire system—this wretched system—a very large number of subscribers, so large a number that in the proper management of your department you shut up your exchange?—Very nearly so. But you must remember that we are not a competing business company; we are simply the Government.

There you were trying to compete?—No.

If you could have made it pay you would have kept it open?—Well, we might.

Plymouth was not an isolated instance, was it?—No, I think not. There were many places.

With reference to telegraphs, you have had interference from similar things to tramways, have you not?—Yes, we have had interference from the South London Electric Railway.

That is worked with an uninsulated return?—A single wire and earth return, but they use the rails for the return inside an iron tube. The Deptford electric light current disturbed the telephone circuits, but not the telegraph circuits, that witness remembered. A tramway might disturb more than electric light currents, but not more than such a system as that carried out at Deptford, which was on alternate current lines. In Leeds itself, the Post Office lines had no disturbance, but they did have the presence in their telegraph circuits of small currents, which they had no doubt came from the tramway. Witness used the telephone in London very largely, and every day, but frequently with difficulty. One reason why he thought it desirable to have a return wire was that the telephone wires were frequently put on the same poles which carried the telegraph wires, and there was thus danger of interference from induction. The whole of the Government telephone system was, with rare exceptions, either in culverts underneath the roadways or run upon telegraph poles; they much preferred to have them underground if they could get them there, and could work them there. He did not think it was a matter of enormous difficulty to put a large commercial telephone system underground; he found it was cheaper to put wires underground when they reached a certain number. With regard to tramways, supposing there were no difficulty about insulation, it would be a convenient method of supplying electricity to have an aperture in the rail, and so communicate between the conductor underneath and the motor in the car. His recollection was that in every case where secondary batteries had been used for tramway purposes they had proved a failure; but it was, of course, only a question of expense.

Sir RICHARD WEBSTER: Have not the local authorities at Wandsworth tried to get the Post Office to put their wires underground, and did not the Post Office resist it, and produce figures showing that it cost ten times more to put them underground than overground?—Yes, that is to have the one wire. In the case of one wire, the difference of expenditure is quite ten to one; but where you come to 30 or 40 wires, the tables are turned.

And when you are dealing with subscribers, a very considerable portion of the route may be one wire?—Yes.

Re-examined by Mr. BOUSFIELD: Are you the only apostle of the the double-wire system?—By no means. It is very widely advocated.

The Government, I think, has only been widely extending its telephonic system within the last year or two?—No, we have been extending our telephonic system from the earliest day, but lately we have taken to extending the trunk system.

My learned friend referred to two or three places where there was only one subscriber. What does that mean?—It means that a man at a place like Talywain is in direct communication with Cardiff, and he comes in on the whole of the trunk system which serves South Wales. There is no exchange in this one particular town.

Can you give a reason why in Plymouth the population seemed to prefer the National exchange system to yours?—One cannot predicate the mind of the commercial public. It was probably a question of rental more than efficiency.

You were asked as to the practicability of underground returns, and as to the expense. Where, as in a case of this kind, a number of wires ran for a mile or two along a street where there is an electric tramway, what do you say as to the expense of grouping all those wires into one underground conduit for that one or two miles; would that be a practicable thing to do?—It would be a practicable thing to do, because the expense would depend upon the number of wires.

Mr. JUSTICE KEKEWICH: It has been said that you can get the *Great Eastern* into Hyde Park if you only found the money, but the question is whether it can be done reasonably, within reasonable limits of commercial success?—It is a thing that is done very largely; when the wires centre along a main street, they are very frequently put underground, owing to the difficulty of putting them overhead, and when you have 20 or 30 wires going overhead, it is the simplest thing in the world to put them underground in pipes.

Do you think it is convenient, if it can be avoided, to have underground wires as part of the system, and overhead for another part?—There is no inconvenience at all. You see that with our exchanges; take, for instance, that of Newcastle, the principal bulk of it is underground, and the remainder in all the suburbs would be overhead, and there is no inconvenience whatever.

Mr. BOUSFIELD: Have you ever in practice in London found cross-talk or "overhesring" become such a serious disturbance that you were not able, practically, to use a particular wire?—Oh yes, in certain districts of London. At one time it was very serious between the City and Westminster.

Do you think, having regard to all the circumstances, that storage batteries could be practically used, commercially used, for the purpose of working a tramcar in a city?—It depends on the battery. The batteries of the past have been failures; but it is not at all impossible to make batteries that may surmount all the difficulties of a tramcar.

I am dealing with the batteries that have been existing during the last year. I think they must be regarded as failures.

Mr. JAMES SWINBURNE, examined by Mr. BOUSFIELD, said he was a member of the Council of the Institution of Electrical Engineers, and also of the Physical Society. In 1881 he was in charge of the Swan Electric Factory in Paris; in 1882 he was in charge of the Swan Electric Works in America; in 1884 and 1885 he was in the incandescent lamp department of Messrs. Hammond & Co's works, and for some years subsequently he was electrician to Messrs. Crompton and Co. He was now carrying on business as a consulting electrician. He had been called in to examine the defendant's tramway, and the effect it had on the use of the telephone in Leeds. That tramway was conducted on the Thomson-Houston system, which had had a phenomenal development in the States, and appeared from the results

of experience there to be, on the whole, the best system. The tramway at Leeds struck him as being a very good specimen, and well constructed in every way. He did not think the variations in the contacts between the trolley and the wire, and the wheels and the rail had any substantial effect in disturbing the telephones. He could not say what the effect of those contacts alone would be, but he could say that by eliminating those contacts he did not think it would make any difference in the disturbance of the telephone. There were other methods of employing electricity for street tramways, but he did not think there was any other so well fitted for the case. It was common knowledge that a very large number of different methods had been tried in America and in England, and on the Continent, but more especially in America. Excepting the cases of Buda Pesth and Vevey, he did not know of any system except the single-wire overhead system, which had proved practically successful for tramway work; of course, in a simple straight back and forward line the double trolley could be used without incurring some disadvantages which would be incurred in a place like Leeds. The collecting of the current was a difficult thing, anyhow, and if you had to do it from two overhead conductors, it was a very much more difficult thing than if you had to collect it from only one; and, in addition to that, the overhead double-wire system produced no end of complications. With regard to the junctions or crossings, you practically had to have a double system above all conductors, and you had your system of rails below. When you have to go round junctions, you have to give your attention to your rails and your points when you are dealing with electric cars. If you have a horse car it is a remarkably easy thing, because you make the horses go on one side, and they generally tread on the mechanism which connects your points. You could not do that with electricity, so that the man had to give his attention to the various points in a complicated crossing; he had to give his attention to the people crossing, to the traffic, and so on; and if, in addition, he had put on him the necessity of looking after a complicated set of overhead switches, it was really too much for one man. The model put in seemed to him to represent the crossing intended in as simple a way as possible under the circumstances. Witness explained the various points of the model, upon which

Mr. JUSTICE KEKEWICH asked what the municipal authorities would say to that arrangement.

Mr. BOUSFIELD: I should think the municipal authorities would say it is utterly out of the question to have this sort of thing in the street. This is what it is suggested we should have. This, it must be remembered, is not by any means a complicated crossing. It is nothing to what you would have in a town very often; it is only a T, two double lines and one single one carried on straight.

WITNESS, resuming, said he did not think that was a practicable system to apply to a place like Leeds. There was a difficulty with regard to short-circuiting that if you had these double wires within comparatively short distances of each other, you might by any sort of accident short-circuit them; that was to say, you might connect them one to another with a high potential of 300 volts and get an electric arc across, which would fuse both the wires at that point, and they would fall on the street.

Mr. BOUSFIELD: How far are the wires apart?—I do not know how far they ought to be actually. The various constructions have been mostly suggested by the plaintiffs, and we do not adopt the double system. But in the ordinary course you might put them 8 inches apart, and so could get 8 inches short circuit. A trolley might leave one side if it had got a good current; contact might break before it touched the other, then you would have the arc. These trolleys are continually leaving the wires. Then, of course, a system like that affords temptation to small boys. It may sound a trivial thing to say, but it is quite possible that all sorts of accidents of that kind would occur. A kite, for instance, might fall across, and might, or might not, cause a break. Then a telephone wire falling across might cause short circuiting. You might have to erect special guard wires over that system, not only for the sake of preventing our current getting into the telephone wire that has broken, but for the express purpose of preventing any wires of any sort coming across our two conductors. The Board of Trade insist upon a guard wire to provide for accidents of wires falling. There are no guard wires shown in that model, so that there would be another network of wires above, though not so complicated.

As regards the support of that arrangement, it is supported by a number of wires at the end sideways?—Yes. At the curves they have what they call pullovers, a lot of almost radial wires kept taut holding the thing exactly at the right curve. To hold it at the right curve requires careful adjustment, and, to a certain extent, difficulties come in, due to the contraction and expansion of the whole. Changes of temperature are apt to alter the level of the whole system up or down; if the expansions are unequal it will alter it unequally.

We have heard of the breaks that have to be made where one conductor crosses a conductor of positive polarity. What would be the effect of that running connection, having regard to the possibility of stoppage?—If the car were running slowly from any reason whatever, and it came to a place like that, it would probably stop, and I do not see any way of starting it, except getting out and pushing the wheel round.

Two suggestions were made, one to have two fishing rods to each wire?—That is an ingenious suggestion, but I think the man would have trouble enough with one pair. It would give a driver four fishing rods to look after going round a place like that, and I do not think it is practicable. That would mean four trolleys.

Another suggestion of Sir Frederick Bramwell's was that there should be a longish brush, sufficiently long to bridge over the gaps, and that that brush on curves should go in between guides which should keep it in contact in its whole length with the wire?—I might be unfair to Sir Frederick Bramwell's suggestion, but that sounds to me a hopelessly unpractical method of arranging an overhead system. You are adding to the present system two more arrangements for each wire to act as guides for these brushes, and you are taking these long brushes. I should think it very unlikely you would ever get them to keep these on. A long flexible brush of that kind, 4 feet long, we will say, in the air, made flexible and bent round by guides fixed in the air at a crossing like that would, I think, not be practicable.

Now, with regard to the ingenious arrangement which was shown in that little model which Sir Frederick Bramwell brought this morning, what do you say as to the practicability of those two switches pulling one after another and crossing over one another in the particular way there shown?—I think it is very ingenious, but it is not a method known to tramway engineers, and therefore, in the first place, not a method the Leeds tramway people could have been expected to have taken up. In the second place, I have not thought about it enough to see exactly how it would work in the long run, because when you see a new thing like that you generally see its merits first, and the demerits come in when you come to try it. I think there would be considerable difficulty in this, and it would increase the difficulty of keeping the trolleys on, because so far we have considered the fishing rod to be vertical under the wire it is collecting from. In this case the centres of the fishing rods are the centres of the car, and if you have two of them they would be a little out sideways. I do not know whether that is an important point. I think you would have a difficulty in arranging these overhead points, but I do not think the thing is theoretically impossible in any way.

It is put forward as a solution of the difficulty. Do you think it is a practical solution of the difficulty?—No, I am afraid it would be too complicated.

Do objections of the same or of different kinds apply to the Vevey system?—Objections of much the same kind apply and additional objections apply because the tube is large and heavy. It being a tube it cannot be bent about like a wire comfortably, and these inside shuttles are not a convenient way of collecting. Such a system could not be practically applied in Leeds; nor could the Buda Pesth system. An inch and a quarter slot would never be allowed in a town like Leeds. There are a great many difficulties in working by means of a knife carrying conductors through a slot into a conduit. There is the difficulty of getting sufficient insulation in the slot underground, which is always damp, and it is very unsuccessful, because you can only get at it here and there. If enough slush and mud got into rest directly on the support of the conductors it would break down the insulation. Generally speaking the mud goes straight through and falls down clear of the conductor, but of course it might not do so. On a snowy day, when the snow was melting and there was an inch or two of slush in the street, the slush would gradually get into the culvert, and if not cleared out it would eventually fill it up until it touched the conductors, but apart from that, all these things falling into the conduit cause dampness, and it is difficult to get the conductors dry enough to insulate properly the bearers of the copper conductors.

Then as regards the knife carrying the conductors through the slot, does that present any difficulties?—It presents several, of course. It wears down through friction, the car is continually swaying from side to side, and then if the knife has a certain amount of spring it continually touches one side or the other, and in a great many cases the knife is so arranged that when it catches it jerks the knife out of the car altogether and lets the car go on rather than break the knife. The difficulties are less the wider the slot; a three-quarters of an inch slot would be very difficult as regards the working of the knife, and also as regards cleaning the culvert out.

When you reduce the slot below three-quarters of an inch do you think it still remains possible to carry this system out in such a place as Leeds?—It is possible, but I do not think it is advisable. There is no such thing as impossibility in these cases; if you choose to spend enough money and to face enough difficulties you can do it. I say it is not commercial; I would not look upon it as a good commercial scheme.

Have you considered the cost of working the conduit system?—Some years ago I went into the matter carefully to find what it came to, and I found the capital expenditure was very serious compared with the overhead system.

Do you consider that any of these systems other than the one that has been adopted could have been practically applied with success in the town of Leeds?—No, I do not.

Coming to the telephone, what is your view of a telephone which makes use of the earth return?—I think in some cases one system is good and in some cases another, but I think generally you could characterise the earth return as a cheap and nasty arrangement. It is very much more easily disturbed. The sensitiveness of the telephone is enormously greater than that of a telegraph instrument, going into thousands of times, and for small alternating currents such as we use in speech, and such as are caused by disturbances, the telephone is far and away the most sensitive instrument that even scientific men know.

Mr. JUSTICE KEKEWICH: I am beginning to believe that.

Mr. BOUSFIELD: That is an important part of our case.

Sir RICHARD WEBSTER: It is part of our case, as far as that goes.

Mr. BOUSFIELD: Supposing on short circuits, or comparatively short ones, that instead of having a complete metallic return, you had a return wire back again, and brought it to earth near the exchange, to what extent, in your opinion, would that obviate the disturbance?—It would not be quite as perfect as a completely insulated metallic circuit, but it would be practically so. You would get rid of the disturbances, not only those due to an electric lighting company or a tramway company, but also those due to cross-talk and telegraphs, and everything. Witness proceeded to describe tests of several telephones at subscribers' houses at Leeds. He tried the experiment of using a complete metallic circuit, of which two sides were along the tramway, and the third side was straight across country. There was disturbance in that case. Then he tried using the double metallic circuit round the two sides, the circuit being

tested occasionally, and it was quite clear that when a proper metallic circuit was used, it was quite perfect as regards disturbances. Upon the results of these experiments, witness came to the conclusion that there might be some mischief caused by conduction, but it was practically swamped by the mischief caused by induction. He heard disturbances to some extent on a fair number of the telephones spoken of by Dr. Hopkinson; but he did not find that he had any difficulty in speaking through, nor that the people at the other end had any difficulty in speaking to him. At one of the places alluded to as being the worst, the subscriber replied to witness's query: "I can hear you pretty well." Witness spoke from the telephone office. They gave him there every facility, and allowed him, practically, to call up any subscriber. He called them up one after the other as if he belonged to the telephone exchange, and asked them if they had any complaint, and they said "No," generally. Some had little complaint about the instruments. Then he nearly always put the question: "Are you disturbed by the tramways?" and their answers varied. Sometimes they said "Yes; there is a disturbance;" but the general answer was that it was not so bad as it used to be. He asked them all whether they were ever stopped from speaking entirely, and he understood not.

Mr. BOUSFIELD: To what do you attribute the apparent diminution of the disturbance in Leeds?—Probably it is due, not to any diminution of the disturbance, but to the people getting more accustomed to the use of the telephone. To put a very familiar instance, it is just the same as when you go into a theatre; at first you have very great difficulty in hearing what the actors are saying, but after you have been there often you have no difficulty whatever. At Dr. Jessop's the reply was, "We hear sometimes noise;" but there was no noise at that time. The note made regarding Mr. Lupton was: "The running of the tramway can be heard. We can speak well with the subscriber, who says that sometimes the noise is so loud as to prevent talking." These experiments were made on May 9th, 1892.

How do the difficulties and disturbances in this district compare with the every-day annoyances on the telephones which you have to submit to in London?—I think certainly, if anything, London is worse. There is a great deal more cross-talk in London, which is very much more annoying, because it is very much more difficult to disentangle the effect on your ear. This is simply a noise which is not like talking.

Assuming that connections are made to water pipes in this district, having regard to the fact of that system of water-pipes being there, with the pipes running along the greater part of that road, what course would the telephone currents take?—Generally speaking, mostly by the water-pipes; that is to say, nearly the whole of each telephone current would go by the pipes and not by the earth.

What would be the effect on the telephone circuit of induction from the tramlines upon the water pipe part of the circuit?—In many cases such induction would produce disturbance in the telephone, though a telephone wire was not near the tramway. I mean the telephone wire is one part of the circuit, and the water pipes would be the other, and you could influence the telephones either through the water pipe part or through the overhead part of the circuit.

This concluded the examination of the witness, and some conversation ensued as to the suggestion of his Lordship that some independent person should during the holidays go down to Leeds and test the telephones in order to set at rest the question of fact. Eventually it was agreed that his Lordship should nominate some person for the purpose, who would give evidence upon the resumption of the case, which was then adjourned to January 12th, 1893.

(To be continued.)

THE VEVEY-MONTREUX ELECTRIC RAILWAY.

COMPILED BY A. RECKENZAUN.

COST OF CONSTRUCTION, OPERATION AND MAINTENANCE.

ALTHOUGH this electric railway has been in operation since the year 1888, then the longest line of its kind in Europe, little has been said concerning it by the technical press this side of the English Channel. Thanks to certain statistics recently published by *L'Electricien*, we are enabled to supply many useful figures relating to the cost of construction, as well as the cost of operating the line under discussion.

The length of the line is slightly over 6·5 miles. It is mostly single track, metre gauge, with frequent turn-outs. The overhead conductors consist of a pair of slotted copper tubes, forming a complete and insulated electric circuit. These tubes have an internal diameter of about ·6 of an inch, and measure outside about 1 inch; they are supported upon wooden arms projecting from poles, and, in addition, they have a steel wire stretched from pole to pole, which take up the sag of the copper tubes. Besides these substantial copper tubes, there are four feeders of ·36 inch diameter, leading from the generating station to the farthest end of the line. The entire weight of copper employed on this railway reaches about 35 tons.

The electrical energy is furnished by a central station supplying light as well as power, and the machines are actuated by a waterfall. The E.M.F. at the terminals of the generator is 500 volts, but the mean potential on the line is only 367 volts. The cars are constructed to carry 30 passengers; they weigh, empty and without motors and gearing, 2·3 tons. The motors, gearing, and electrical accessories are stated to weigh ·82 of a ton, a very modest figure when compared with the weights of motors used on American tramlines.

A remarkable feature on this line has been the "*tubier*," a man whom we might call the trolley-boy, who sat on the roof of the car and guides with his hands the contact slides in the tubes, especially at the turn-outs. There are consequently three *employés* on each car, viz., the driver, the conductor, and the trolley-boy. We comment upon this functionary elsewhere in the present issue.

The daily service is maintained with 13 motor cars. At the completion of the line in 1888 the capital expenditure was as follows:—

	£	s.	d.
Purchase of land for the depôt and survey	813	3	0½
Sleepers, rails and attachments ... £6,995 6 9			
Switches, crossings, turn-tables ... 299 2 1½			
Digging and laying the line 1,561 1 5½			
Ballast 273 14 5½			
	9,129	4	9
Poles, cables, tubes, and all attachments 4,511 5 7½			
Putting up the overhead lines ... 647 0 8½			
	5,158	6	4
Buildings, stations, workshops	782	19	6½
Signals, telephones and indicators	40	4	5½
Rolling stock with motors and accessories	3,760	0	0
Furniture, tools and instruments	218	10	4½
Total	£19,902	8	6½

Up to the year 1890, through improvements, increase of rolling stock, &c., the capital charges have been increased as follows:—

	£	s.	d.
Line and installation	21,352	1	11½
Rolling stock, 15 cars	5,388	4	5½
Furniture, tools, &c.	306	9	4½
Total capital expenditure ...	£27,036	15	9½

For the year 1890, the gross receipts were £7,404 17s. 10d.

Working expenses.	Total. £	s.	d.	Per car mile. d.
Management	753	4	0½	·73728
Maintenance of line	760	15	8	·75264
Traffic control	1,159	15	9½	1·13664
Wages: Drivers and conductors	995	0	2½	·95232
" Cleaners and labourers	141	10	5½	·10752
Maintenance and renewals of cars	480	17	6	·47616
Maintenance and renewals of dynamos	232	17	8½	·2304
Maintenance and renewals of cables	20	3	6	·01536
Maintenance and renewals of contact slides	52	6	10½	·05836
Maintenance and renewals of sundries	12	9	8½	·01382
Cost of motive power	1,200	0	0	1·16736
Heating of cars	20	17	9½	·01843
Lighting cars	34	10	3½	·0384
Cleaning materials	27	5	8½	·03993
Lubricants	17	9	2½	·01689
Lighting, heating, and cleaning buildings	40	8	8½	·04608
Stationery	27	12	0	·03993
Sundries	222	2	7½	·21964
Total	£6,199	7	8½	6·0672

Total expenses per annum ... £6,199 7s. 8½d.
" " " car mile ... 6·0672 pence.

It will be observed that notwithstanding the comparatively low operating expenses, the ratio of the expenditure divided by the receipts amounts to 83·7 per cent. This is probably due to the small winter traffic on a line which depends largely upon excursionists.

NOTES.

Cardiff Electric Lighting.—Now that the question of an electric lighting scheme is being discussed, some correspondents of the Western dailies are recommending the utilisation of water power of which there is such a plentiful supply for the purpose. Application is to be made to the Local Government Board for sanction to borrow £32,500 for the purposes of erecting an electric lighting station, purchasing and fixing necessary plant, laying high and low tension mains, transformers, &c.

Marykirk Electric Lighting.—Prof. Blyth, while staying in this village recently, kept a series of storage cells charged with electricity for lighting his house. The motive power was obtained from a large windmill erected in the garden. Last week he took advantage of a passing traction engine to drive the dynamo, and by an arc lamp of 200 C.P., lit up the village.

Australian Telegraph Rates.—The Exchange Telegraph Company states that the Indian Government have yielded to the remonstrances addressed by the official representatives of the Australian colonies to the Secretary of State for India, and have consented to abandon their intention of increasing the transit charge on cable messages from England to Australia which pass over the Indian land-lines, from 35 centimes to 50 centimes per word. The Indian Government considered that, as the charge for cable messages to Australia and *vice versa* has been increased from 4s. to 4s. 9d. per word, they were justified in increasing the land rate by 15 centimes. Now, however, they will adhere to the old rate of 35 centimes so long as the cable tariff remains at 4s. 9d.

Presentation.—Mr. H. J. Vose, who has recently been appointed to the post of Superintending Engineer, Post Office Telegraphs, for the South Wales District, was on Thursday, the 5th instant, presented with a very handsome dining-room clock by his late colleagues of the Engineer-in-Chief's Office, General Post Office. The presentation was made by Mr. J. Hookey, Assistant Engineer-in-Chief, and Mr. Vose, in a few well-chosen words, thanked him and the donors generally for the gift.

Society of Arts.—On Friday next, January 20th, at 8 p.m., the second of the Howard Lectures on "The Development and Transmission of Power from Central Station," by Prof. W. Cawthorne Unwin, F.R.S., will be delivered. He will deal with the following subjects:—Water power—Increase of availability of water power if transmission is possible—Types of water motors—Governing of hydraulic motors—Cost of water power—Storage of power by reservoirs and accumulators—Systems at Zürich and Geneva.

"Money and Trade."—After twenty years' career as a weekly critical review of banking, insurance, and finance, *Money* has determined to appeal to a wider constituency. It appears this week in a greatly enlarged form, and under the more comprehensive title of *Money and Trade*.

Hanley Electric Lighting.—Although a Local Government Board enquiry was held some weeks ago, and the contract for the electric lighting given to the Brush Company, a number of members of the Town Council now consider that the time has not yet arrived when they should expend £20,000 on an electric lighting scheme. The matter was fully discussed at a meeting last week, when it was resolved by 15 votes to 8, that the question be not re-opened, the resolutions already passed having been acted upon.

Dublin Electric Lighting.—The borough surveyor, and Mr. E. Manville, the electrical engineer at the central station, have drawn up an interesting history of the enterprise, with some hints to intending customers. The pamphlet is suitably illustrated.

Workhouse Electric Lighting.—Some additional workhouse premises are to be erected at Edmonton, and a proposal by Messrs. Holmes and Sons to light them by electricity is receiving the consideration of the Local Authority.

Kingston Electric Lighting.—The Town Council have decided to obtain tenders for the purpose of supplying electricity for 5,000 private incandescent lamps, and 30 or 40 arc lamps for street lighting, and to take the necessary steps to borrow £16,000 for carrying out work.

Bath Electric Lighting.—The question of the defective electric lighting of the city is to be left over for a month, in order that a certain test may be made at the works by the inspector.

Tunbridge Wells Electric Lighting.—The report of the Electric Lighting Committee on the cost of an electric lighting installation is to be printed and circulated amongst the members.

Burnley Electric Lighting.—Mr. Thomas Parker has been appointed consulting engineer in connection with the Burnley electric lighting installation at a fee of £400, to include his services for preliminary report and the wages of a clerk of works.

Halifax Electric Lighting.—Steps are to be taken for supplying electricity for lighting purposes, and an electrical engineer is to be engaged at £200 per annum.

Irvine Electric Lighting.—On Saturday last, Mr. David Alexander, of Messrs. Norman & Son, electrical engineers, Glasgow, made an inspection of the Burgh Mill at Irvine for the purpose of reporting as to whether the water-power there could be utilised in connection with the lighting of the streets and harbour with electricity.

Reading Electric Lighting.—The draft provisional order was submitted at a meeting of the Reading Town Council last week, and it was reported that the proposed amendments had been submitted and approved by the Electric Lighting Committee.

Beckenham Electric Lighting.—Mr. Gisbert Kapp has estimated the cost of the necessary works to provide electricity for the compulsory area at £8,500, exclusive of land.

Edinburgh Electric Lighting.—The Edinburgh Town Council Committee last week had under consideration the terms of the report to be submitted to the council by the electric lighting deputation.

The Pacific Cable.—The daily papers state that a telegram from Ottawa on January 11th reads as follows:—"The Dominion Government has decided to ask the Imperial authorities to appoint a commission to enquire into the feasibility of the Pacific scheme, and to offer to pay the expenses of the Canadian member of such Commission."

Dundee Electric Lighting.—The question of lighting the Parochial Board Offices by electricity is to be discussed by the same committee as are considering the lighting of the Council Chamber and the Burgh Court Room.

Compensation for Injuries.—In the Brompton County Court, last week, Frank Cornet, a Fulham workman, recovered damages for personal injury to the amount of £50 against the Electric Supplies and Fittings Company, having hurt his arm by a fall from a defective ladder while in their service.

Glasgow Electric Lighting.—At the meeting of the Town Council a question was asked as to when they were to have the electric light in the streets. In reply, it was stated that the committee expected to have had the work completed before the New Year, but they were not getting on as quickly as they anticipated. It was then expected to be completed before the beginning of February, but it seemed they would not have the electric light in operation even then, because in such weather as now prevailed it was impossible to open the streets and push on with the work as quickly as desirable.

Liverpool Electric Lighting.—The Council Chamber at the Town Hall was on Wednesday, last week, lighted for the first time by the electric light.

Electric *v.* Cable Traction.—A committee of the Glasgow Town Council have prepared a report on the different modes of tramway traction. They recommend that cable traction be further considered, as the comparative inducements of electric traction are not sufficient to justify its adoption at Glasgow.

Portrush Electric Lighting.—A committee has been formed to consider the best means of lighting the town by electricity.

Frome Electric Lighting.—Enquiries are being made as to the advisability of having an electric lighting installation.

Electrolytic Separation on a New Principle.—Starting with the assumption that electrolytes are present in a dissociated condition in an aqueous solution, M. Le Blanc argued (*vide Zeit. Physikal Chem.*, viii., p. 299) that the electrical energy required to separate the ions from the solution would be given by the product of the amounts of electricity peculiar to each ion into the intensities with which these amounts may be attached to the ions. The intensity of attachment will vary with the nature of the ion, but will always be the same for the same ion, provided that the influence which the solvent may be supposed to exercise on the dissolved substance remains constant. If the electromotive force, which is just sufficient to produce a separation of the ions from a solution of a given salt, be accepted as a measure of the intensity of attachment of the electricity to the ions, constant differences might be looked for, Le Blanc argued, in the values of the electromotive force for salts having common ions. This E.M.F. for normal solutions of a number of salts was measured, and the results were found to be confirmatory of the above view. The paper which we have quoted extended over 32 pages, and dealt with a number of experiments with organic substances. The conclusion which is most interesting in connection with the subject of this note was that in a solution the amount of the electric charge is identical for one and the same ion, and that, therefore, the point of decomposition of an electrolyte may be exactly determined. As this value differs very considerably for the various metals, it has recently occurred to H. Freundenberg that metals might be separated from each other by employing currents of different electromotive force, and the experiments which he has already made show that such is really the case. These experiments are necessarily of a simple character, but one may be quoted as an illustration. A current of 1·35 volts caused the separation of silver from copper and bismuth, and mercury from copper, bismuth, and arsenic. The analyses which were also made showed a very close agreement with the theoretical numbers.

Runcorn Electric Lighting.—In accordance with a resolution passed by the Runcorn authorities, the probable cost of securing an electric lighting installation for Runcorn streets is being enquired into.

Personal.—Mr. Arthur C. F. Webb, of the New South Wales Government Telegraphs, and third son of Mr. F. H. Webb, Secretary of the Institution of Electrical Engineers, was married at Sydney, on November 23rd, to Eva Florence, second daughter of Mr. E. C. Cracknell, Chief of the Department. Among the numerous presents received by the bride and bridegroom was a silver tea service presented by the telegraph operators, and Mr. Webb also received a silver cigar case from the students of his electrical engineering class at the Sydney Technical College.

Electricity in Switzerland.—The civil authorities of Bulle are inviting projects, says *Industries*, for a central station for lighting and power purposes. A central station has been recently put into operation at Langenau. The plant, which comprises dynamos and transformers of the Ganz type, has been put down by the Zürich Telephone Company.

The Telephone in Austria.—According to the recently published report of the Minister of Commerce, says *Industries*, there were at the end of 1891 sixty-four telephone exchanges and twenty-three trunk lines in operation in Austria.

Aldershot Electric Lighting.—The Local Board has decided to apply for an electric lighting provisional order, and to refuse certain applications for permission to supply electricity.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

National Electric Supply Company, Limited.—The annual return of this Company made up to the 9th ult., shows that out of a capital of £100,000, in £5 shares, 100 founders' and 10,425 ordinary shares were taken up. The full amounts have been called, and the sum realised reaches £51,920. There is £705 in arrear.

Swan United Electric Light Company, Limited.—The yearly return of this Company made up to the 13th of last December, shows that out of a capital of £1,000,000 in £5 shares, 78,949 ordinary and 19,750 fully paid shares had been taken up. An amount of £3 10s. has been demanded on each of the ordinary shares, and the payment resulting from this call reaches £279,851 10s. A sum of £3,530 has been paid on 1,201 forfeited shares and £98,750 has been considered as paid on the 19,750 fully paid shares.

Aluminium Company, Limited.—The annual return of this company made up to November 17th, 1892, shows that out of a nominal capital of £400,000, all the shares had been taken up, and the 20,000 "B" shares issued as fully paid. The full amounts have been called upon the 60,000 "A" shares and all calls, reaching the sum of £300,000, have been paid. The company was registered on June 18th, 1887, to acquire from Webster's Patent Aluminium Crown Metal Company, Limited, the patents of Mr. Jarvis Webster for the manufacture of alumina, aluminium and other metallic alloys, and also the patent rights of Mr. Hamilton Y. Castner for the manufacture of sodium and potassium. Both The Right Hon. A. J. Balfour, M.P., and G. W. Balfour, M.P., are among the principal shareholders.

Boy Messengers and Electric Call Company, Limited.—The annual return of this company, as filed at Somerset House, shows that out of a nominal capital of £200,000, in £1 shares, 30,000 shares have been taken up. There has been 16s. called up on each of 25,000 shares, and the total amount of calls received reached £19,888 12s. It has been agreed to consider £5,000 as paid. The aggregate amount of calls unpaid is £120 8s.

The Bournemouth and District Electric Supply Company, Limited.—The annual return of this company has been filed at Somerset House, and shows that out of a capital of £50,000, in £5 shares, 5,725 shares have been taken up. There has been £5 called on each of 5,725 shares, and the total amount of calls received reaches £12,850. There is still £484 unpaid, and £15,775 has been agreed to be considered as settled.

Bickle & Co., Limited.—The statutory return of this company has been made, and shows that out of a nominal capital of £50,000 in £10 shares, 2,021 shares, with £5 called on 1,021 of them, have been taken up. There has also been £5 paid in advance on 455 shares. The total amount of calls received is £7,288, and that agreed to be considered as paid £10,000. A sum of £172 is yet outstanding.

Collier Audible Telephone Syndicate, Limited.—The shareholders of this syndicate, at extraordinary general meetings held at 4, Coleman Street, on October 1st and 17th last, passed a resolution to the effect that the company should be wound up voluntarily, and that the liquidator should be authorised to carry out the sale of the assets of the syndicate.

Birmingham Telegraph Factory Company, Limited.—The annual return of this company, made up to the 8th ult., shows that out of a nominal capital of £50,000 in £10 shares, 707 shares have been taken up. There has been £10 called up on each of 307 of these. The total amount of calls received is £3,010; and that agreed to be considered as paid is £4,000. There is £60 yet unpaid.

American Insulated Wire Company, Limited.—In accordance with the Companies' Act, 1862, the secretary of this company has filed a notice at Somerset House, which states that the registered office of the concern is situated at 15, Union Court, Liverpool.

Association for the Protection of Telephone Subscribers, Limited.—According to a notice that has lately been filed at Somerset House, the registered office of this company is situated at 58, Coleman Street, E.C.

CONTRACTS OPEN AND CLOSED.

OPEN.

Berlin.—January 20th. For the supply of (*a*) copper sheets, bars, and wire; (*b*) brass sheets and wire; (*c*) zinc, zinc sheets, &c., for the Prussian Royal railways. Further particulars from the Director of Stores, Körnerstrasse 7, Berlin.

Bourges, France.—January 20th. For the supply of 41,100 kilos of brass, 25,300 kilos of brass and copper to the Central Military School, for the Bourges municipality. Further particulars from the Hôtel de Ville, Bourges.

The Hague.—January 17th. For the supply of iron telegraph posts (Henley system), iron insulator supports, &c., for the Dutch Telegraphs Administration. Further particulars from the chief telegraphic engineer, the Hague, Holland.

CLOSED.

Derby.—For building electric lighting premises for the Town Council: Messrs. Vernon, £6,324 17s. 5d.

BUSINESS NOTICES, &c.

Manchester Edison-Swan Company, Limited.—This company has had an unsually busy year, not only has the volume of their installation work considerably increased, as will be seen from the following list of some of the installations which they have carried out during the year, but they have considerably increased their manufacturing department, of which dynamo building forms a considerable part:—Union Club, Manchester; Brazenose Club, Manchester; the Palatine Insurance Co., Manchester; Commercial Union Assurance Co., Manchester; the Union Bank of Manchester, Manchester; the *Manchester Courier* offices, Manchester; the *Sheffield Independent* offices, Sheffield; Empire Theatre of Varieties; Edinburgh; the Empire Theatre, Hanley; W. Wood, Princes Restaurant, Manchester; Tyson's Restaurant, Manchester; Queen's Hotel, Rawtenstall; Grimsby Town Hall, Grimsby (re-wiring); Wholesale Co-operative Society Shoe Factory, Leicester; M. Ross & Sons, warehouse, Manchester; W. Turner & Sons, cotton mills, Pendleton; North British Rubber Co., Manchester; Baerlein & Co., warehouse, Manchester; J. Wood, Bros. & Co., cotton mills, Glossop; Tootal, Broadhurst, Lee & Co., cotton mills, Bolton; F. Martin, Esq., Gloucester; Inman Steamship Co., Ltd., Manchester; Bruderer & Co., warehouse, Manchester; Elkington & Co., silversmiths, Manchester; J. Whitehead, Rochdale; Bye & Co., Ltd., Manchester; C. Lowe & Co., chemical waters, Reddish; W. B. Pidduck, jeweller, Manchester; A. Clason and Co., Manchester; Stephenson, Routley & Co., wine merchants, Manchester; Miles Ashworth Mills, Rochdale; Muir, Duckworth and Co., Manchester; J. Wainwright, Manchester; J. Hall & Co., Manchester; F. Livingston & Co., Gorton; Schofield Bros., Manchester; W. H. Milner & Co., Manchester; F. Baum, photographer, Manchester; John Martin, Esq., Huddersfield; S. Hartley, Littleborough; W. Jowett, Marple; Thompson, McKay & Co., Manchester; Henderson, Craik & Co., Manchester; Simpson, Howden & Co., Manchester; Cunliffe & Swires, Rochdale. As a result, the company's present factory in Little John Street, Manchester, has become too small, and they are projecting large new works outside the town. In the course of a month they hope to move their present showroom from Barton Square to fine new premises which they are building on the Exchange Station Approach; they will there have, in addition to the principal showroom, which has a window frontage of over 38 feet to the street, dark rooms in the basement fitted up by eminent fitting manufacturers, also several sets of electric light plant in operation. This company is at present applying for a provisional order covering the districts of Altrincham and Bowdon, the most wealthy residential suburbs in Manchester, and propose to lay down a central station having a capacity of 15,000 8-candle-power lamps.

Eclipse Electric Lighting Syndicate.—The *London Gazette* contains an announcement to the effect that the creditors of the above Company are required on or before 14th February, to send particulars of their debts or claims, &c. to Mr. Ernest Richard Wood, of 8, Finsbury Circus, London, E.C., Solicitor for John Garford, of 3, Vernon Chambers, Southampton Row, W.C., and Willoughby Hamilton Power, of 2, Pancras Lane, E.C., the Liquidators of the Company.

The India-rubber, Gutta-percha and Telegraph Works Company, Limited.—The following is a short summary of the work done by this company during the year 1892. In addition to the usual India-rubber and gutta-percha manufactures, the following work has been carried out by the electrical departments: A submarine cable, of over 2,100 knots in length, has been made and laid, connecting the network of cables at Senegal, Africa, to Pernambuco, in Brazil. Another cable, to duplicate the system originally laid by this company for the Central and South American Company, has now been completely manufactured and shipped on board ss. *Silvertown*. This cable, of a total length of 2,620 knots, will be laid from Salina Cruz (Mexico), to Chorillas, Peru, touching at St. Elena (Ecuador), and San Juan del Sur (Nicaragua). In addition to the above, a considerable amount of cable has been manufactured for some of the telegraph companies and the British and foreign Governments, making, in all, a total of about 5,400 knots manufactured during the year. Electric light cables have been supplied, and in some cases laid, for the underground electric light system of the following towns: Dublin, Leeds, Oxford, Cambridge, Dundee, and Glasgow. The demand for cables and wires for installation work has been very satisfactory; and the Silvertown Company has been fortunate enough to secure practically all the orders for Admiralty main cables, from the time that India-rubber insulation has been adopted, to replace the fibrous covering previously used, but now abandoned. A fair business has been carried on in electrical machines, including a few sets of dynamos supplied to the British Government and the extension of the Hague Tramway Company, which is run on the accumulator system, with most satisfactory results—both as regards freedom from breakdown and receipts. In addition to the above, installations have been carried out for ships, factories, and private houses; and the instrument and batteries shops have been fairly well employed on Government and other work.

Catalogues, Price Lists, &c.—A very fine catalogue is that just issued by the Electric Construction Corporation. It is evident that a great deal of trouble and expense have been incurred in this publication to ensure it being a first-class book. It has been very cleanly and carefully printed in two colours on good paper, and the illustrations, of which there are a number, look very well. The book is also very nicely bound in a neat cover. In the front there is shown a street view of the works at Wolverhampton. There are six full page plates which illustrate alternating current dynamos, continuous current dynamos, electric tramcar conduit system, electric travelling crane, switchboard, Elwell-Parker continuous current dynamo, 450 H.P. A number of pages are devoted exclusively to illustrating and describing these Elwell-Parker dynamos, and the information therein given is plainly set out. Elwell-Parker electro-depositing machines and dynamo sundries are also fully referred to. Alternating current transformers, high tension fuse blocks, switchboards, double-pole high-tension switches, voltmeters and ammeters, and similar apparatus are dealt with, as are also Elwell-Parker arc lamps. The book is, on the whole, a first-class catalogue and can be confidently recommended.

A new price list for 1893 of wires and cables for all electrical purposes has been brought out by the United Electric Wire Company of Clerkenwell Green. The pamphlet contains a good deal of information and will be very useful to the company's customers and users of electric wires generally.

Messrs. J. Hopkinson & Co. have sent us a number of their lists of patent parallel slide valves, blow-off valves, safety valves, Hopkinson's "own make" steam, &c., gauges, patent "absolute" water gauges; also some notes to those ordering new boilers. We have pleasure in recommending these lists to all users of steam power.

Messrs. Edward Winnall & Co., of 8, George Street, Minories, have brought out an illustrated price list of the Livingstone electric bells.

Electric Lighting in the West End.—Since our last report we note that electric lighting work has been carried out in the "John O'Gaunt" Hotel, Sardinia Street, W.C., also in the premises of Messrs. P. B. Wells & Co., 431, Strand, and in Messrs. Anstiss & Co.'s wine bars, 405, Strand.—A contract has also recently been carried out in the new premises of Mr. John J. Woods, 212, Strand; also one in Morle's Hotel, Jermyn Street, Piccadilly, and one in the English and Scottish Law and Fire Office, Waterloo Place.—An extensive installation is at present being carried out in the Royal College of Medicine at South Kensington, by Mr. Ronald Scott.—Mr. Roger Dawson is carrying out the following electric lighting contracts:—Lord George Hamilton, 17, Montague Street; Lord Brougham, 30, Chesham Place; Dr. Ridge Jones, 4, Chesham Place; Mrs. Bingham, 19, Chesham Place; Mrs. Tollemache Scott, 10, Chesham Place; T. Crampton, 7, Chesham Street; H. Hayman, 18, Pembridge Square; L. Waterhouse, 31, Montague Square; Turtle and Appleton, Bryanston Mansions (300 lights); also 73, New Bond Street; 39, Albert Hall Mansions; 41, Albert Hall Mansions; 27A, Sackville Street; 30B, Portman Mansions; 44, Kensington Park Road; 39, Carlyle Square; 29, Ashley Gardens.

The Henley Telegraph and Electric Construction Company, Limited.—At Extraordinary General Meetings of the above named Company, held at the registered offices of the Company, 6, Clement's Lane, Lombard Street, London, E.C., on 5th December, 1892, and on the 21st December, 1892, the following resolution was duly confirmed, viz.:—"That the Henley Telegraph and Electric Construction Company, Limited, be wound up voluntarily." And for the purposes of winding up, James H. Stephens, of 6, Clement's Lane, Lombard Street, London, E.C., was, by an ordinary resolution of the members, appointed liquidator.

Mather and Platt.—Messrs. Mather and Platt, Limited, of 16, Victoria Street, Westminster, are carrying out an electrical installation at the East London Water Works, Lea Bridge, and putting in a Manchester dynamo and a set of accumulators; the mains to the various buildings being overhead bare stranded copper conductors, the total number of lights being about 250. Messrs. Mather and Platt have also received the order for the fitting up the Manchester New College, Oxford, including the library and chapel, with 247 lamps; the current is to be obtained from the Oxford Electric Lighting Company. The same firm are fitting up for electric light the *Lancet* offices, Bedford Street, Strand, with 125 lamps.

Novel Electric Stage Effect.—In Mr. Oscar Barrett's present production at the New Olympic Theatre, a novel and brilliant electrical effect is produced in one of the scenes of "Dick Whittington." During this scene the stage gradually darkens, and suddenly a cloud-like screen, placed in the background, is illuminated with a number of tiny incandescent electric lamps, which appear to scintillate and sparkle like veritable stars. To produce the effect, 400 incandescent lamps run on twenty distinct circuits, are employed. The batteries for working this installation are placed on the stage, and are of the Lithanode type. This original electric screen was designed and manufactured for Mr. Barrett by the Lithanode and General Electric Company, of Westminster.

Electro-Medical Apparatus Company.—This is the title of a new company which has been formed for the supply of electro-medical apparatus, such as L.K. current controllers, measuring instruments, L.K. batteries, portable batteries, electric baths, electric douche, electro-gymnastic apparatus, and electrical rooms. The managers are Mr. H. Newman Laurence, M.I.E.E., and Mr. Alan Kirk; the offices being situate at Trafalgar Chambers, 36, St. Martin's Lane, W.C.

Cable Interruptions.—The Eastern Telegraph Company, Limited, notifies that communication with South Africa is interrupted, both *via* the west and east coast routes. The company's cable-repairing steamers are in the locality of the breaks, and communication was expected to be restored early this week.

Festive Illuminations.—A treat was given to the children of the Ward of Farringdon Without last Tuesday, when the Edison and Swan United Electric Light Company kindly supplied the electric glow lamps for the monster Christmas tree, whilst Messrs. Lund Bros. & Co., of Oxford Street, undertook to do all the necessary works incidental to the illumination of the tree by electricity.

Electric Light in the City.—The following contracts are in course of completion by Mr. Roger Dawson:—London and South Western Bank, Tokenhouse Yard; 90, Southwark Street; 70, Basinghall Street; 65, Basinghall Street; Simpson's Chop House, Cornhill; A. Isaacs, 32, New Broad Street; R. A. Notley, 80, Cornhill.

Personal.—Mr. Charles G. Barrie, of the Lapmas Nitrate Syndicate, leaves by steamer *Iberia*, on 18th inst., for Chili, where he will assist Mr. Jamieson in the erection of a complete electric lighting plant. The plant is now on its way to the West Coast of South America. The contract was carried out by Mr. Scott, of 11, Bow Lane, E.C.

Appointment.—Mr. W. Perren Maycock, M.I.E.E., has been appointed electrical correspondent to the *Ironmonger and Metal Trades Advertiser*. All communications relating to new fittings, instruments, &c., should be addressed to him at 42, Cannon Street, E.C.

Partnership.—Messrs. Pritchetts, of 31, Soho Square, inform us that they have taken Mr. A. G. Gold into partnership, and the name of the firm will be Pritchetts and Gold.

Preston Electric Supply Company, Limited.—The annual supper to the *employés* of this company took place last week.

CITY NOTES.

International Okonite Company, Limited.

THE adjourned ordinary general meeting of this company was held on Tuesday last at Cannon Street Hotel, Mr. Samuel Pope, Q.C., presiding.

The CHAIRMAN said he felt that he personally owed the shareholders just a few words of apology and thanks. He was unfortunately absolutely unable to be present at the general meeting, and no doubt the information which then was given to the shareholders was not of the fullest nature, and they adjourned the meeting. This was, therefore, really the continuation of that meeting. They would resume the discussion on the report and balance-sheet at the point where they left off at the adjournment. He could only say that he would be glad if any shareholder would ask for any information upon any point upon which he desired it, and, as far as he (the Chairman) was concerned, either by himself or through the officers of the company, any explanation should be offered as far as the question was capable of explanation. There were just a few questions, however which were raised on the last occasion, and which he would say a few words regarding, and he was anxious that the shareholders should understand the position in which they were as the adjourned meeting. He would tell them with perfect frankness what course he proposed, as chairman, to take with regard to certain matters, and then he would be very glad for the whole question to be discussed by the meeting itself. The first question which appeared to him to require a word was that of the £20,000 which practically had been refunded out of the purchase money by the original vendors, who were the managers in America, and which caused very great anxiety and negotiation at the commencement of the year. They found in the course of their business, as the report said very clearly, that the valuation of the stock upon which their previous profits had been nominally based, was practically an over-sanguine valuation. Of course, therefore, they felt bound, as directors, not to proceed to present any balance-sheet in which the credit assets were, in their judgment, over-valued, and, of necessity, the present balance-sheet had to be prepared upon an amended valuation of stock. It was true and legitimate value, and therefore, because the credit of the previous year had proved a larger valuation, the profits of the previous year would be diminished by the amount which they thought it necessary to write off the original valuation, because the profits depended very largely upon the true valuation of the stock. They therefore inasmuch as their previous balance-sheet had been very largely based upon the valuation for which their American colleagues were responsible, and largely also upon the valuation for which the original vendors were responsible, because they constituted the committee of management on the other side, sent the general manager over with a view to insisting upon some return to the company of the purchase money which had been paid upon the basis of such a valuation, and after very considerable trouble they did induce them to hand up for purposes of cancellation, £20,000 worth of the shares which had been handed over to them in payment of the purchase money, and that £20,000 had been treated as a reduction of the capital, because, of course, the shares which were issued, and upon which dividends, if any, should be earned, would have to be payable, was diminished by the £20,000, which they had handed over for the purpose of being cancelled. That seemed to him to be fairly and correctly stated in the report, and he owned that he did not see how they could have treated in any other way the amount which had been so refunded, because it was practically £20,000 repaid out of the purchase money by reason of their insisting that the valuation to that extent should be rectified. He himself would never have been a party to presenting a balance-sheet, although it might be that it would show no profit for the half-year, if he were to show a profit by an over-valuation of the stock, although that might have been the principle which had been acted upon before, and, therefore, one of the main features of the balance-sheet was that they hoped, when they had started with a proper valuation of their stock, to have a real true sound valuation, and although, of course, the writing off of that £20,000 from the valuation of stock prevented any profit accruing this year, the advantage of it would be hereafter derived, because in the future there would be no such over-valuation to contend with. They would simply value their stock upon the principle adopted on the present occasion. There were now some minor questions which he would deal with. Something, he thought, was said at the last meeting in enquiry as to the London expenses, which amounted to something like £2,000 odd. They were really expenses of the entire company in England, because, wisely or unwisely, it was not for him to say now, their company, though largely consisting of property and business in America, was by its constitution managed by a board sitting in London. He quite agreed that if they were dealing with the question *ab initio*, it might be a very grave question whether experience had found such an arrangement to work satisfactorily, however, as it was, those total expenses, which consisted of such items as rent, rates, taxes, printing, stationery, postage, wages to the secretary, accountant, and various other incidental expenses which were, of course, unavoidable, amounted to a little over £2,000, but of that amount £750 was repaid to the company by other companies who had the advantage of using their staff and establishment, so that the net would be the amount which appeared in the balance sheet with the allowance of £750 received from the others. The Manchester business showed a considerable loss. The directors were unanimous in their opinion that it ought not, and they were equally unanimous in their opinion that the management of the Manchester business had been not only disastrous but disgraceful, and they had therefore thought it right to remove from the service of the company the gentlemen who had hitherto been in charge of the Manchester business. They were unanimous in believing that they would be able to reorganise the Manchester works upon a basis which would make it satisfactory and profitable, but they were equally unanimous that the agreement which in the first instance was made with the vendors of the Manchester business, had operated to hamper the discretion of the directors, and that at any cost, if cost be necessary, that must be got rid of and a clean sweep made at the Manchester end. That could not be done in a moment or without difficulty. He would have a word to say presently with regard to the views which had been submitted to many of the shareholders by others on this point. He knew there must be some difference of opinion, and he would at once frankly say that the directors were unanimous upon the matter; if there were a feeling upon the part of the shareholders that the Manchester business should be left in the hands of those with whom the original agreement left it, the directors must ask to be relieved of their responsibility of the management of the concern, as they would not consent to hold office under such conditions. Addressing Mr. Conolly, the Chairman said: "We think that you, Mr. Conolly, have so mismanaged the Manchester business, that we are justified in discharging you from the business of the company, and if you can turn us out to put yourself in, do it; but you will not come in as long as we hold seats upon the board." Addressing the shareholders, the chairman said that some of

them had submitted certain views to the general body, and some of those criticisms he thought were well worth all respectful consideration; but they must first secure management which they thought to be competent and honest. He then referred lengthily to, and read a circular letter which had been sent round to a number of the shareholders, but not to all. The proxies held by the senders of that circular covered 1,803 shares, distributed amongst 79 shareholders; but the directors held proxies for 11,221 shares, and he put it thus to those gentlemen, by all means let them have an open ventilation of opinion. If the directors were put to it, he should rule against their using proxies, but he would tell them that the directors had that overwhelming number of proxies, which was a sign of the confidence of the shareholders. The circular which he read was signed by Messrs. John Kenyon (100 shares), H. L. Peters (50 shares), Thomas Thorp (240 shares), Ed. Gladstone (10 shares), Wm. Griffiths (30 shares). 430 shares, therefore signed the circular proxies delivered since amounted to 1803, so that out of the total capital of the Company there were a very small amount represented in that opinion. The board would be glad to give every information on questions which might be asked, but he would insist on conducting the business of the meeting in the strictest order. In conclusion he moved the adoption of the report and balance-sheet.

Mr. GLADSTONE asked: Do not you propose to give any information on the balance-sheet itself?

CHAIRMAN: I have nothing to say on the balance-sheet as it seems to be clear enough.

Mr. GLADSTONE: Who are the vendors to this Company?

CHAIRMAN: The vendors to this Company were the American Okonite Company.

Mr. GLADSTONE: I refer to the vendors, Messrs. Woodhouse & Rawson.

CHAIRMAN: Woodhouse & Rawson showed to us the agreement they had made with the Okonite Company.

Mr. HOLT inquired whether the profits certified by Messrs. Price, Waterhouse and Company were *bona fide*, and whether an independent valuation had been made. He also inquired what proportion of the £325,000 which was paid for the property was for patents and goodwill, and what profit Woodhouse and Rawson took out of that amount. He likewise asked who was responsible for giving estimated profits of £56,000 and £80,000, which had now turned into a loss of £6,800. The company looked to him like a bogus one. He could not understand why the directors, who were men of business, should have paid such a large price for the concern, and he could not help thinking that there must have been some great carelessness on their part. He thought there ought to be a committee of investigation.

A number of further questions were asked, and statements were made by Messrs. Hawkins, Gregory, Holt, Col. Hemans, Mather, Griffiths. Most of these speakers complained that the board had not had an independent valuation of the business made before purchasing.

Mr. BOND said, while not wishing to embarrass the board, he expressed the hope that the chairman would give them some reasons why the Manchester business had not been successful.

Mr. HOPPS criticised the item of £2,500 set down for directors' and managing director's remuneration. He also asked whether any request had been made to the present trustees asking them to resign their trusteeship in order to appoint other trustees? He considered okonite better than any composition of its kind that had been used, and he was of opinion that if it were put on the market they would be in a very much better position than now.

Mr. GREGORY having again spoken,

Mr. F. RAWSON said that the business in America was certainly a most profitable one, but in the year after the company was formed great depression existed in America. It was true that Woodhouse and Rawson were responsible for the valuation, but they did everything they could to check the statements and protect the shareholders as far as possible, and one of the firm of Price, Waterhouse and Co. had gone fully into the books. He regretted as much as anyone that any differences had arisen between Messrs. Shaw and Conolly and the board. He believed if the shareholders supported the board that the business would be a profitable one.

After further discussion, in which Messrs. GLADSTONE, SHAW, KENYON, MATHER and SQUIRES took part,

The MANAGING DIRECTOR (Mr. Alfred Vaughan-Stevens) stated, in reply to the various questions which had been asked, that Woodhouse and Rawson had made a profit of £45,000 by the sale of the business, on paper; but, as a matter of fact, they had not made a half-penny, because the whole of that profit was represented by shares or debentures in the company, and therefore they were in the same position as themselves. The working capital of the company had been expended, owing to the advice of experts of the company, headed by Mr. Conolly, before they knew where they were. Had they spent their money properly, they would have made the profit mentioned in the prospectus. Their late works manager had grossly mismanaged the Manchester factory, and he had been discharged, and at present they were trying to find a new manager. The American business was steadily increasing, the sales for the month of November last reaching $92,000.

The CHAIRMAN having also replied, the motion for the adoption of the report was carried by a large majority.

A SHAREHOLDER asked regarding the disappearance of the names of Lord Greville and another director from the report, and in reply the Chairman said that Lord Greville resigned because he did not like the duty cast upon him as chairman. The other director ceased to hold a seat, practically, because he had not the necessary qualification.

The meeting then re-elected Messrs. Price, Waterhouse & Co., as auditors, after which a vote of thanks was given to the chairman and board.

Liverpool Overhead Railway Company, Limited.

A SPECIAL general meeting of the shareholders in the Liverpool Overhead Railway Company was held last Tuesday at Liverpool, for the purpose of considering a resolution for the creation and issue of preference shares, Sir William Forwood (the chairman) presiding.

The CHAIRMAN explained that the purpose was to create 12,500 preference shares of £10 each, carrying a dividend of 5 per cent., 7,500 of which would be issued at par. The rules of the Stock Exchange required a public issue; but the shareholders might be assured that their own applications would be favourably considered. The Chairman passed on to explain that the additional capital for which the due powers had been obtained was required to extend the railway northwards to Seaforth, to tap a large and populous district, and that the necessary work could be done cheaper now, when the plant was on the ground, than at a later time. He referred to the fact that the cost of construction had been somewhat greater than anticipated, for various reasons, and complimented the shareholders upon their patience. Speaking of the adoption of electricity as the motive power, he said the directors felt confident that this was a wise choice, although it involved additional outlay in the beginning. One great advantage was the amount of electricity used, and therefore the amount necessary to be produced could be closely governed by the necessities of the traffic.

Mr. R. HOBSON seconded the motion.

A sharp discussion followed as to the necessity of a public issue of the preference shares, opinions being expressed that the shareholders should have the right to them.

The CHAIRMAN explained that the public issue was desired simply to comply with the rules of the Stock Exchange, and in order to secure a Stock Exchange quotation. This, however, did not appear to satisfy many of those present, and Mr. Inglis moved an amendment in favour of the allotment of the shares primarily to existing shareholders. This was duly seconded, but on a vote being taken it was lost by 21 votes to 17.

Mr. INGLIS then demanded a poll, refusing to be satisfied with anything less than a distinct promise from the chairman that the shares would be allotted as he desired.

The CHAIRMAN said he could not, in view of the rules of the Stock Exchange, give such an undertaking; but, short of an absolute undertaking, the shareholders might be assured their claims would receive full attention. He asked for confidence in the board of directors.

Mr. INGLIS replied that he had no confidence in the board after the way they had treated the shareholders in the matter of issue of the debentures.

To this Mr. HOBSON replied, explaining that the action of the directors in the matter might have been mistaken; but it was *bona fide*, and conceived in the interests of the shareholders.

Mr. LISTER denied that the action in question had been mistaken; on the contrary, he, as a shareholder, thought it was wise.

After some further discussion, Mr. INGLIS, at the instance of a number of shareholders, who expressed themselves satisfied with the assurances of the chairman, withdrew his demand for a poll.

The resolution was then carried, and the proceedings closed.

Gordon and Fell, Limited.—The business of Messrs. J. E. H. Gordon and Company, of Pall Mall, and the general contracting business of John Fell, of Leamington, have been amalgamated, the name of the new Company being Gordon and Fell, Limited, of which the capital is £100,000 in shares, and £100,000 in five per cent. first mortgage profit debentures in 2,000 bonds of £50 each. The share capital has been taken up by vendors in respect of their purchase-money. The average profits of the two businesses during the period at which an examination of the accounts was made are stated at £13,750 per annum. The two directors, at present, are Mr. J. E. H. Gordon, and Mr. John Fell, who will undertake the practical management of the business for a term of not less than 5 years. The subscription list opened on Monday, 9th inst., and closed yesterday (Thursday, 12th inst.).

Stock Exchange Announcements.—The Stock Exchange Committee have ordered the undermentioned Securities to be quoted in the Official List:—Elmore's Patent Copper Depositing Company, Limited—Additional Shares, Nos. 82,441 to 91,240.

Globe Telegraph and Trust.—An interim dividend of 1s. 3d. per share has been declared by the directors, payable on the 20th instant.

Babcock & Wilcox.—A half-yearly interim dividend at the rate of 10 per cent. per annum is announced, payable on February 14th.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending January 8th, 1893, amounted to £998; week ending January 10th, 1892, £858; increase £140; total receipts for half-year, 1893, £998; corresponding period, 1892, £858; increase £140.

The Cuba Submarine Telegraph Company. The estimated traffic receipts for the month of December were £3,600; as compared with £3,420 in the corresponding month of last year.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 6th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,507.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation January 5th.	Closing Quotation, January 12th.	Business done from January 1st to 12th, 1893. Highest.	Lowest.
195,100*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102 xd	100— 103	101½	100
1,247,720*l*	Anglo-American Telegraph, Limited	Stock	51½— 52½	51½— 52½	51¢	50⅜
2,876,140*l*	Do. do. 6 p. c. Preferred	Stock	93 — 94	92½— 93¼	93⅜	92⅛
2,876,140*l*	Do. do. Deferred	Stock	11 — 11½	11 — 11½	11⅛	11
130,000	Brazilian Submarine Telegraph, Limited	10	11 — 11½	11 — 11½	11⅜	11⅛
34,600*l*	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	104 —108 xd	104 —118	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3 — 3½	3 — 3½	3 3/16	3½
75,000	Do. do. Non cum. 6 p. c. Preference. Nos. 1 to 63,416	2	2¼— 2½	2¼— 2⅜	2 7/16	...
125,000*l*	Do. do. 4½ per cent. Debenture Stock	Stock	100 —102	100 —102	101½	100½
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
600,000*l*	City and South London Railway	Stock	35 — 38	35 — 38	37½	35
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	10½— 11	10⅜— 11¼	11	10 15/16
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	5¼— 5½	5¼— 5⅜	5⅜	5 5/16
$7,716,000	Commercial Cable, Capital Stock	$100	175 —180	175 — 180	179	176½
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	3/16— 5/16	3/16— 5/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5 — 5½ xd	5 — 5½	5 5/16	...
16,000	Cuba Telegraph, Limited	10	11½ — 12½	11½ — 12½	...	...
6,000	Do. do. 10 p. c. Preference	10	17½ — 18½	17½ — 18½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2 — 3	2 — 3	2 1/16	2⅜
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	9½	...
60,710	Direct United States Cable, Limited, 1877	20	11¼ — 11½	11¼ — 11½	11½	11¼
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜— 15	14¼— 15	15	14⅜
70,000	Do. 6 p. c. Preference	10	16 — 16½	16 — 16½	16½	16
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	109 —112	110 —113	111½	110
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅜— 15	14⅜— 15	15	14 11/16
70,600*l*	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	102 —105 xd	152 —105	...	...
250,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105 xd	102 —105	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	110 —113	111 —114	112	110½
122,400*l*	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	100	101 —104 xd	101 —104	104½	102
163,700*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104 xd	101 —104	...	...
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	103 —106	103 —106	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	2¼— 2⅜	2¼— 2⅜	2⅝	2¼
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1/8— 3/16	1/8— 3/16	3/16	1/8
82,395	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3/16— 1/8	1/8— 3/16	1/8	3/16
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1/8— 1/4	1/8— 1/4	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅜— 10	9⅜— 9 15/16	9 15/16	9 11/16
180,042	Do. do. 6 p. c. Preference	10	15 — 15¼	15 — 15¼	15¼	15
150,000	Great Northern Tel. Company of Copenhagen	10	19 —19½ xd	18⅞— 19¼	...	...
210,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	104 —107	104 —107	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½— 5½	4½— 5½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	8 — 9	8 — 9	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½— 22½	21½— 22½	22	21⅝
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	44 — 46	44 — 46	45⅛	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½— 3½	2½— 3½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6 — 7	6 — 7	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	3⅝ — 3⅞	3⅝ — 3⅞	...	...
10,000	Do. do. fully paid	5	5 5/16— 5 7/16	5¼ — 5½	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	108 —111	108 —111	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6⅜— 7¼	6⅜— 7¼	7⅛	6⅝
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	102 —105	102 —105	101½	...
454,747	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 5	4⅜— 5	5	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	14 — 15	14 — 15	15	14½
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13⅜— 14½	13⅜— 14½	14	...
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	4¼— 4⅜	4¼— 4½	4¼	4 5/16
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	111 —113 xd	111 —113	112¼	111½
48,800*l*	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	4⅜— 5	4⅜— 5	...	...
6,318	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16— 5/16	3/16— 5/16	...	...
11,802	Reuter's Limited	8	7½— 8½	7½— 8½	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7⅜— 8⅛	7⅜— 8⅛	8 3/16	8
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8¼— 8⅜	8¼— 8⅜	8⅜	8⅜
3,381	Submarine Cables Trust	Cert.	117 —122	117 —122	119½	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3 — 3⅛	3 — 3⅛	3⅜	3⅛
37,350	Telegraph Construction and Maintenance, Limited	12	45 — 47	45 — 47	46½	45½
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	101 —104 xd	101 —104	...	...
58,000	United River Plate Telephone, Limited	5	2⅜— 3⅛	2⅛— 3	2⅜	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 —100 xd	90 — 100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6½— 7½	6½— 7½	...	...
260,900*l*	Do. do. do. 5 p. c. Debentures	100	100 —103	101 —104	101½	...
30,000	West Coast of America Telegraph, Limited	10	2½— 3½	2½— 3½	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	100 —104 xd	101 —105	103	102
64,242	Western and Brazilian Telegraph, Limited	15	7½— 7⅝	7¼— 8	7 13/16	7½
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5½— 6	5⅝— 6¼	5 15/16	5⅝
33,129	Do. do. do. 5 p. c. Deferred	7½	1¾— 2¼	1¾— 2¼	2	...
184,100*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	106 —109	106 —109	...	...
230,100*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	106 —109	106 —109	106½	...
88,321	West India and Panama Telegraph, Limited	10	1¼— 1½	1¼— 1½	1⅜	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10¼— 10⅜	10¼— 10⅜	10⅜	10¼
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8½— 9½	8½— 9½	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	103 —106 xd	104 —107	...	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
171,000*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —103	100 —103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5½— 6	5½— 6	5⅞	5¾

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. Bank rate of discount, 3 per cent. (October 20th, 1892.)

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7⅝.—Brush Company 4½ per cent. Debenture stock, issued at 1 per cent. premium, 100—103.—Electric and General Investment, shares of £5 (£1 paid), 1¾—2⅛xd.—Founders' shares, 200—225.—Electric Construction Corporation, 6 per cent. Debentures, 95—98.—Electricity Supply Corporation, Ordinary of £5, 5—5¼.—Elmore Foreign and Colonial Copper, Founders shares, 6¾—7⅛.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 1⅜—2⅛.—Do. 7 per cent. Preference of £5, 5—5⅛.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 6—5⅛, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6—6·.—Liverpool Electric Supply Shares of £5 (fully paid), 5¼—6¼.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Queen Anne's Mansions Lighting and Heating, Debentures, 101—103.—Woodhouse and Rawson £5 Preference (fully paid), ¾—1¼.

REVIEWS.

Electric Lighting and Power Distribution. By PERREN MAYCOCK, M.I.E.E. London: Whittaker & Co.

This work, of which we have the first part before us now, is designed by a teacher to meet the requirements of his junior students. The method throughout is characterised by the most careful thought, and nowhere does the author lose sight of his intention, namely, to make matters clear to those who are anxious to learn. There is no attempt at popularising technical terms, and yet, by familiar illustrations and analogies, and by the use of plain language, the author succeeds in putting fundamental principles in such a form that there should be no difficulty in grasping their significance by those who have a rudimentary knowledge of natural philosophy.

At the commencement, mechanical, physical, and electrical units are dealt with. The difference between *mass* and *weight* is very clearly put; but we might suggest that the derivation of the formula:

$$\text{force} = \text{mass} \times \text{acceleration},$$

might serve to impress this important distinction upon the mind of the beginner.

By definition, the weight of a body is caused by the force exerted by gravity tending to change its motion, so that, obviously, weight is only another term for force exerted, hence we may write *weight* instead of force in the last formula, and arrive at

$$\text{mass} = \frac{\text{weight}}{\text{acceleration}},$$

which shows that at whatever point in the universe the lump of lead be weighed, its mass must be a constant quantity, since we define it as the ratio of the effect (weight) to the cause (acceleration of gravity), which called the weight into existence. We mean by this to suggest that the student should not be allowed to imagine that we know anything about *mass* absolutely, or that we can measure it any better than by a ratio of effect to cause. Precisely similar reasoning applies to the definition of electrical resistance. We can only measure this practically as the ratio of the electromotive force to the current flowing in the circuit, or

$$\text{Resistance} = \frac{\text{electromotive force}}{\text{current}}.$$

It might also be pointed out that the mass of a body can only be measured relatively to the force it exerts in obedience to the law of gravitation, and to that alone, and not by the force it exerts in obedience to any other influence, such as magnetic attraction, wind pressure, a blow, &c.

Mr. Maycock also insists upon the fact that electrical *pressure* only can be generated. It is a widely spread fallacy amongst the type of electrical engineers so common nowadays, that a dynamo generates "electricity"—draws it out, as it were, from the field magnets.

We can congratulate Mr. Maycock upon having produced a book which cannot fail to be useful to all who are genuine students of electricity and its methods. His science is sound, his definitions accurate, unnecessary wordiness is conspicuous by its absence. We can conscientiously recommend it as fulfilling the object of its existence, and students will find it worth their while to read every word of it. We look forward to the appearance of Part II.

House Lighting by Electricity. By ANGELO FAHIE. London: E. & F. N. Spon.

In the preface to this little work, the author expresses the hope that "it will be found to fulfil the object for which it was written, namely, to explain in a familiar and popular manner the means whereby we may best accomplish the desirable task of lighting our homes by electricity."

The degree of success attending such an "explanation" as this, is measured by the extent to which it appeals to the average intelligence of the class for whom it is intended, and we cannot say that the ordinary public will be any the wiser for the very sketchy utterances regarding dynamos, transformers, arc lamps, and so forth, which form part of this work. The words "explanation" and "description" are frequently held to be synonymous, but this is far from the case. A purely technical matter may be *described*, but can never be accurately explained in popular language without resorting to clumsy wordiness, or to a string of analogies which often make "confusion worse confounded." The author has, in our humble opinion, attempted to cover far more ground than could possibly be well treated in so few pages. As a result, the reader, who is presumably a non-technical individual, is at every turn confronted by a technical expression, by way of a short cut to the end of the "explanation."

We need hardly say that, with one or two exceptions, due probably to an oversight, or to a clerical or printer's error, Mr. Fahie's statements are correct, and an electrical engineer has no difficulty in seeing exactly what is meant; but it is hardly for this class of reader that the book is designed.

Where Mr. Fahie avoids the thankless task of dealing with technical apparatus in popular language, he gives a good deal of sound information, very useful to those unacquainted, by profession or experience, with electrical matters. Chaps. II. to V. are interesting. Chap. VI. deals with the vexed question of the relative cost of gas and electric light, which is discussed in seven pages. This most important question deserves treatment at greater length, and in much more detail.

Chap. VII. is disappointing, in that it disposes of an interesting subject, "The Management of the Electric Light," in three pages of matter. The subsequent chapters deal briefly with electric motors in their application to domestic economy, electric cooking and heating, and so forth, and concludes with useful hints to users of the electric light, and an appendix showing the cost of installation of houses of various sizes. These tables are, however, not compiled from actual practice, but are estimated by the author at a schedule rate per lamp for wiring, and a further rate for fittings.

The book is interesting, but owing to recent similar publications, can hardly lay claim to novelty. We are glad to note that the author disposes of the somewhat foolish fallacy that the electric light is injurious to the sight by quoting undeniable authorities, and also gives interesting data as to the effect of the light on the growth of plants. We welcome every publication destined to diffuse knowledge of electrical matters, and we wish Mr. Fahie's book every success.

Practical Electric Light Fitting. By F. C. ALLSOP. London: Whittaker and Co.

This work aims at rigid "practicalness." As a result, we find inaccuracies in the use of terms bearing a more or less scientific significance. Thus we learn that "conductivity" is the reciprocal of "resistance." The reciprocal of resistance is now usually denoted by the word conductance, conductivity being used to express the specific conductance of a body. In similar senses, the words resistance and resistivity are employed. In the description of the dynamo, we read that "the amount of flow of electricity is governed directly by the resistance of the conductor joining the two terminals of the machine, and indirectly by the winding and construction of the machine." We must confess our inability to quite follow this statement.

Current, electromotive force, and resistance are disposed of very quickly, and the author enters upon the real subject-matter of the book, namely, a description of every piece of apparatus used in electric light fitting. There are 221 illustrations in the 270 pages, so that of necessity nearly everything down to a screw must be illustrated.

Two systems of wiring are described and illustrated, namely, the tree system and the distributing board system. But the advantages of this latter system are not sufficiently insisted upon. Moreover, as illustrated, the distributing board system is shown in combination with a modification of the tree. In the true distributing system there should be no T-joints anywhere, and the wire should be continuous and without a joint between the fuse, switch, and lamp terminals.

The book is certainly very complete, and will no doubt be warmly welcomed by those who, according to the statement in the preface, "repeatedly asked the author to produce a book on electric lighting." Mention is made of cooking and heating by electricity, and the Phœnix Fire Office rules are included by "special" permission.

Téléphonie Pratique. Par L. MONTILLOT, Inspecteur des Postes et des Télégraphes. Paris: A. Grélot, 18, Rue des Fossés-Saint-Jacques.

This is an imposing and important work on practical telephony. It commences with a short theoretical sketch, followed by general and historical remarks, which are also brief. These are succeeded by long descriptions of receivers and transmitters of French design—a numerous family, for any manufacturer or inventor who has altered the shape of the magnet in a Bell telephone, or transposed the carbons in a Hughes microphone, gives his own name to the instrument. The receivers are each accompanied by a representation of the effect their magnetic fields produce upon iron filings—a new and not uninteresting feature, but if intended to indicate relative qualities, we fear a misleading one. Telephonic lines, aerial and underground, receive attention, then descriptions of various accessory apparatus; the remainder of the work is principally occupied with descriptions of switching apparatus, with some carefully compiled and well executed diagrams. Whilst much of the apparatus described is peculiar to France, and of interest from a historical rather than a utilitarian point of view, there are some of wider interest. All that are dealt with throughout the work are well described both in letterpress and illustration. The design and execution of the work are alike good.

Modern Mechanism: exhibiting the latest progress in machines, motors, and the transmission of power. Edited by PARK BENJAMIN, LL.B., Ph.D. London and New York: Macmillan and Co.

This work is one of the most important and useful of its kind hitherto published. Being a new book, and not merely a fresh edition of an old one, the temptation to include a large amount of antique matter has been avoided, and as a result, the work deals solely with the principal and most useful advances of the past 10 years. Containing upwards of 900 pages and many hundred illustrations, a vast mass of most useful matter has been brought together. In compiling the book many contributors of eminence have been requisitioned, amongst these being Prof. Elihu Thomson, who writes on "Electric Welding;" Mr. J. Wetzler, on "Dynamo-electric Machines, Electric Motors, Electric Transmission of Power, and the Storage Battery;" Prof. W. C. Unwin, F.R.S., on "The Utilisation of Niagara Falls"; Mr. H. H. Westinghouse on "Brakes;" Captain J. Rapieff on "The Pneumatic Gun." The editor writes on sewing machines, safes, brick machines, fire engines, elevators, &c. A number of specialists have specially prepared articles relating to various subjects, such as "printing presses," "safes and bank vaults," "sewing machines," "steam fire engines," "rope driving," the "Fiske Range Finder," "telegraph" (T. A. Edison), &c. It would be difficult to single out particular articles as being of greater merit than others; they are all written with great impartiality, and do not show any marked American bias. In glancing through the book, articles on "Armour" (armour-plated war ships), "Cotton Spinning," "Machinery," "Dynamo Electric Machines," "Steam Engines," "The Utilisation of Niagara," "Printing Presses," "Saws," "Watches," strike one as being of great interest; but we do not say this in exaltation of the same above many other equally excellent compilations. Taking the work altogether, it would be difficult to praise it too highly; it should prove a marked success.

Index to the *Journal of the Institution of Electrical Engineers.* Vols. xi.—xx. 1882—1891. London: E. & F. N. Spon, 125, Strand.

A good index is an indispensable addition to the Proceedings of Societies, and the one in question, which has just been issued, is no exception to this rule. Its value is unquestionable and, as far as we have tested it, it appears to be compiled with great accuracy.

Pioneers of Science. By OLIVER LODGE, F.R.S. London: Macmillan & Co.

This book takes its origin in a course of lectures on the History and Progress of Astronomy given in 1887. It is seldom that we have come across a work of the kind that has given us greater pleasure in reading it. The "Pioneers" chiefly spoken of are Copernicus, Tycho Brahé, Kepler, Galileo, Decartes, Newton, Romer, Bradley, Lagrange, Leplace, Herschel, Bessel, Adams, and Thomson. Perhaps the most entertaining portion of the book is that relating to Galileo, though it is invidious to make a selection where all is good. Besides being interesting historically, there is a large mass of highly scientific matter put in a form which should prove very taking to many general readers who have a liking for astronomy. A marked characteristic of the book is the delicacy of handling which the author shows, there being an entire absence of any covert or openly-expressed sneers at any religious aspect which it may have been necessary to bring in in the course of the narratives. In this respect (and in others also) the book is a model of what a work of the kind should be. We can speak of the production in the very highest terms, and strongly recommend all who can spare the time, to read it.

STEAM-POWER FROM HOUSE DUST FOR ELECTRIC LIGHTING.

THE Refuse Disposal Company have prepared a pamphlet to show how by their patented process municipal bodies may utilise house refuse as the fuel for their electric light stations.

Assuming a general adoption of such a fuel, one-half of the terrors of our wasteful Mary Anns will be dissipated. At present, when bills for domestic fuel come in, their enormity weighs doubly heavy with a knowledge that it is chiefly due to the unburned portion sent away to a noisome dustheap in the scavenger's cart, a wholly wasted valuable. The enormous amount of coal thus annually thrown away can be saved by means of a few wire sieves. The destruction of house refuse with no useful purpose further than the dessication of the vegetable and other organic matter mixed with it, is itself too wasteful to admit of consideration. The city of Manchester has long utilised much of its domestic refuse, and manufactured considerable quantities of mortar for sale, the final ashes after the cinders have been consumed under the steam boilers, being a valuable ingredient, and imparting a certain hydraulicity to the mortars made therefrom. The particulars given of the experiments made with house dust, simply prove that Mary Anns, as a class, are wasteful and lazy. Out of 1,000 loads of refuse averaging 19 cwts. 0 qrs. 20 lbs., a trifle over 799 tons of fuel, fit for steam boilers, was obtained, the remaining 200 tons consisting of miscellaneous matter, much of which can be utilised for manure and much for paper manufacture. The fuel is compared with Welsh steam coal capable of evaporating 9 lbs. of water per lb. of fuel, and proved capable of evaporating 3·6 lbs. of water, showing itself to be thus 34½ per cent. good fuel, even though the material tested contained some 17 per cent. of moisture. Compared, on the basis of 1,000 gallons of water evaporated, Welsh coal is rated at 22s. per ton, coke breeze at 5s., and house dust fuel at 6d., though how the 6d. is arrived at is not stated. On these figures as a basis, the Welsh coal evaporates 1,000 gallons for 10s. 11d.; the breeze for 3s. 8d., while the house dust costs only 9d. per 1,000 gallons. Practically then, house refuse is equal to a fourth of its weight of Welsh coal and does its work for about one-fourteenth of the expense.

An ordinary destructor at Southampton drives 37½ H.P. of steam engines. Had it been used according to the company's system, the refuse thus destroyed, viz., 60 tons, would give 337½ H.P., which would go a long way to lighting quite a nice little area.

The cost in fuel of 1 I.H.P. is worked out as ·87 of a farthing, and is equal to the production of six-tenths of a unit of electric current. One unit thus costs ·435d., inclusive of stoking and plant depreciation, a sufficiently low figure to admit of a margin for a possibly too sanguine view. Even the above estimate is claimed as excessive, for the disposal of refuse now costs 2s. per ton, and, saving this amount, brings down the cost per unit to ·262d., as against an average of 1·72d. for seven electric supply companies in

London using coal, and this shows a saving of one-half, even with the cheap fuels of the north of England.

Applied to London, the process would have to deal with 750,000 tons annually, the equivalent of 187,500 tons of good Welsh coal.

The company has a small works in operation in Chelsea, and the figures they give in the pamphlet appear reasonable, and the process should be valuable, at least in London, where we are much inclined to think the amount of fuel wasted is greater than is the case where fuel is cheaper. A maker of fuel economisers once stated to us that in Lancashire, with coal at 5s. to 7s. per ton, he could sell a dozen of his apparatus for one he could sell in the south country with coal at 20s., and our own experience points in this direction.

It is not, however, merely as a matter of economy that a good process is required. The system of the Refuse Disposal Company is to deal with refuse immediately it comes in, and all organic matter is at once ground to dust and mixed with other ground material, which at once renders it innocuous. The company claim that they have no undisposable tailings. Everything which cannot be placed in a distinct category goes to the grinding mill and becomes dust, valuable as manure from its organic constituents, and as a means of lightening heavy soils.

The process described in the pamphlet is presented in a very plausible manner; we use the term in its more correct and inoffensive sense, and its success would remove one of the great fuel wastes at present incurred through the incompetence or ignorance of the domestic stoker, while it offers to municipalities a road out of the chronic town refuse slough, and presents a field for employment. To be successful, town refuse requires to be dealt with at or near its point of production. To be so dealt with inoffensively, demands that there shall be no accumulation of decaying matter, and, properly carried out, the described process bids fair to accomplish its aim.

NEW PATENTS—1892.

23,317. "Improvements in thermometers and electrical connections therewith." G. HIGTON. Dated December 19th.

23,321. "Heating liquids by electricity." L. B. MILLER and M. W. WOODS. Dated December 19th.

23,352. "Improved electrically operated locks." E. D. TAYLOR. Dated December 19th.

23,361. "Improvements in writing telegraphic instruments." A' HEIL. Dated December 19th. (*Complete.*)

23,370. "Improvements in incandescent electric lamps." W. F. TAYLOR and G. F. BARNES Dated December 19th.

23,385. "Improvements in electricity meters." H. W. MILLER. Dated December 19th.

23,409. "Improvements in storage batteries." G. A. WASHBURN. Dated December 20th. (*Complete.*)

23,421. "Improvements in sockets for incandescent electric lamps." B. J. B. MILLS. (Communicated by J. Hutchinson, United States.) Dated December 20th. (*Complete.*)

23,453. "Improved method and apparatus for regulating the speed or expenditure of power in vehicles propelled by electrical energy, in particular that supplied by accumulator batteries." C. D. ABEL. (Communicated by La Société Anonyme pour la Travail Electrique des Métaux, France.) Dated December 20th.

23,460. "Improvements in electro motors." H. T. BARNETT. Dated December 20th.

23,476. "An improved process or method of plating or coating aluminium with tin, zinc, or lead, or alloys thereof." R. HADDAN. (Communicated by L. Oliven, Germany.) Dated December 20th. (*Complete.*)

23,477. "An improved process of soldering, applicable to the soldering of aluminium to aluminium, or to other metals." R. HADDEN. (Communicated by L. Oliven, Germany.) Dated December 20th. (*Complete.*)

23,501. "Improvements in devices for electrically playing stringed musical instruments." H. H. LAKE. (Communicated by J. Vose, United States.) Dated December 20th. (*Complete.*)

23,539. "Improvements in or in connection with dynamo-electric machinery." W. L. SPENCE and D. STEWART & Co., Ltd. Dated December 21st.

23,579. "Improvements in electric incandescent lamps." A. ZOBEL and F. BUCHMULLER. Dated December 21st.

23,648. "Improvements in or relating to non-magnetic compasses or course correctors for mariners' compasses." J. MORTON. Dated December 22nd.

23,658. "Improvements in the armouring, covering or protecting of electrical cables and the like." H. EDMUNDS. Dated December 22nd.

23,674. "Improvements in distributing electricity and means or apparatus for the purpose." H. T. HARRISON. Dated December 22nd.

23,675. "Improvements in the construction and arrangement of switches for use in connection with electric generators especially applicable to alternators and their exciters." J. S. RAWORTH. Dated December 22nd.

23,678. "Improvements in electrical measuring instruments." R. A. WORMELL. Dated December 23rd.

23,680. "Improvements in voltaic cells used as standards and for testing purposes." D. G. FITZGERALD. Dated December 23rd.

23,733 "Improvements in and apparatus for the manufacture of chlorine and alkali by electrolysis of compounds thereof and anodes to be employed therein." E. T. PARKER. Dated December 23rd.

23,750. "An improvement in plates for secondary batteries." A. HOUGH. Dated December 23rd.

23,773. "Improvements in electric smelting, and in furnaces therefor." R. NIEWERTH. Dated December 24th.

23,774. "Improvements connected with the obtainment of the electric arc for lighting and other purposes, and in apparatus therefor." R. NIEWERTH. Dated December 24th.

23,783. "Improved electric incandescent or glow lamp." J. PLUMMER. Dated December 24th.

23,788. "Improvements in electro-plating." S. O. COWPER-COLES and the LONDON METALLURGICAL COMPANY, LIMITED. Dated December 24th.

23,805. "A new or improved automatic electric-switching device for use with arc lamps." R. BOMBE and F. SCHUCHHARDT. Dated December 24th. (*Complete.*)

23,824. "Improvements in electrode-supporting combs for electric batteries." A. J. BOULT. (Communicated by Mannheimer, Gummi-Guttapercha and Asbestfabrik, Germany.) Dated December 24th.

23,861. "Improvements in switches and connections for electric circuits." T. COCKERILL. Dated December 27th.

23,892. "Improvements in multiple telephony and telegraphy." M. HUTIN and M. LEBLANC. Dated December 27th.

23,902. "Improvements in alternate current motors." C. E. L. BROWN. Dated December 27th.

23,906. "Improvements in incandescent lamps for electric lighting." F. H. PRENTISS. Dated December 27th. (*Complete.*)

23,919. "Improvements in and relating to electrolytic apparatus." T. CRANEY. Dated December 27th. (*Complete.*)

CORRESPONDENCE.

"Teslaic" Experiments.

By an accident, I have just seen in the *Electrician*, of December 9th, 1892 (with reference to "Teslaic" experiments by Mr. Campbell Swinton), a paragraph from which I quote the following:—

"Mr. Campbell Swinton, however, offers a very attractive theory and one which should be applied to all Teslaic and other high frequency experiments. He argues that by reason of the high frequency, the current is merely skin deep; the resistance is therefore high, since only a very small part of the filament acts as a conductor. The volts are high, and not easily measurable, and though the current is small, the watts spent on the filament are sufficient to raise it to incandescence. The lamp becomes, as he puts it, not a 100 volt lamp, but a 100,000 volt lamp. The whole of the high frequency and therefore harmless theory is thus completely exploded, and a most interesting, and, we believe, new hypothesis is put forward . . . ."

These sentences surprise me in as much as on referring to THE ELECTRICAL REVIEW, June 10th, 1892 ("The Current that Kills"), I read as follows:—

"These high potential and rapidly alternating currents possess very little current strength; in fact, the quantity is infinitesimal, though the total energy is great. For instance, suppose that the initial energy put into one of Tesla's apparatus be 2 ampères at 4 volts, *i.e.*, 8 watts, and that this be so transformed by the apparatus that it comes out at 150,000 volts. Certain loss must take place in the transformation, say it is one-eighth, then the maximum energy obtainable from the secondary circuit is 7 watts. Of this 7 watts the volts number 150,000, so that the current strength can only be less than five hundred-thousandths of an ampère—a current which is too small to be worth a moment's consideration,

and which the most delicate child could handle with impunity."

Surely the first quoted extract is very much a re-production (however, unintentional) of the second?

I fail also to see that the second version is in any way an improvement on the original. A writer, who, in the same paragraph deprecates "extremely unscientific" hypotheses, is scarcely expected, by way of "explanation," to fall back upon the use of such a term as "skin deep" current. The idea, however, contained in the latter expression, had already been developed by Prof. Houston, in a paper read before the electrical section of The Franklin Institute.

W. S. Hedley, M.D.

The "Umbria" Accident.

The accident which recently befell the ss. *Umbria* through the cracking of her propeller shaft, and the heroic efforts on the part of her engineers, points to the conclusion that our magnificent Atlantic liners are not sufficiently equipped with appliances which, in case of need, should prove a great boon to steam navigation. It is impossible to carry a well-equipped engineer's shop on board such a vessel; moreover, ordinary machine tools cannot be readily moved about and applied in confined spaces. However, since every large steamer is now supplied with electric light machinery, it would be easy to carry the current to a most out-of-the-way corner of the ship, and utilise it for actuating tools run by electric motors. A portable electric drill, for instance, could readily have been used for boring the holes in the shaft of the ss. *Umbria*, and the task could have been accomplished in one-fifth the time with very little exertion on the part of the engineers.

Such a drill could be used in confined spaces, where there is scarcely room for a man to stand in. Many of these appliances, of various power and dimensions, are in use in engineers' shops, and they prove an immense saving.

Instead of bringing a boiler, cylinder, shaft, or any other heavy piece of machinery into the vicinity of a fixed machine, portable drills are made which can be carried to the spot of application, and no other connection but a pair of wires is necessary to convey the motive power from the generator to the motor. These machines are efficient and cheap, and they ought to form part of every steamer's tool stores. Numbers of them have been to various engineering works, and we feel convinced that marine engineers and ship-owners will consider them an absolute necessity as soon as their attention is called to the fact that such useful labour-saving appliances are available.

There are numerous mechanical operations being continually performed on board steamships which involve the most laborious hand labour, whereas we have the means within the smallest compass of doing the work of a dozen men with accelerated speed through the medium of electricity at a nominal cost.

The Electrical Company, Limited.

"Starting of Multiphase Motors."

In his last article on "Multiphase Transmission and Distribution of Energy," Mr. A. Reckenzaun alludes to the multiphase motors used in the Lauffen-Heilbronn installation, and says (see bottom of page 784, December 30th, 1892): "The application of multiphase motors has fully justified all expectations, and they give general satisfaction;" and again, towards the end of the article, he points out the adaptability of this motor for fiery mines, owing to the absence of commutator and brushes.

It would be interesting to know if these machines can now be made to start on *full* load. I believe that the machines shown at Frankfort would not do so, those that did any work at all being coupled to fans or centrifugal pumps, which, of course, gave them a chance to get up speed. Most mining machinery, however, is of such a nature, *e.g.*, pumps, hauling and winding machines and coal cutters, that they require to be started with the load on; a clutch could be used, but I am afraid mining engineers would object to it, and it would certainly place the machines at a disadvantage when compared with continuous current motors, such as are now being put down by several well-known firms.

The Westinghouse Company, who have had considerable experience with the Tesla form of multiphase motors, have apparently abandoned them (see a namesake's paper before the American Institution of Electrical Engineers, Chicago) for the simple alternator, two conductors, as advocated by Mr. Mordey several years ago.

Ernest Scott.

Continuous to Alternating Current Transformer.

I notice that in a description of high period alternating current apparatus in your issue of December 9th, 1892, the statement is made that "nothing has been accomplished within a tithe of 1,000,000 alternations per minute." I do not know what fraction of 1,000,000 a tithe is, but Mr. Tesla and myself have worked with machines which gave about 1,000,000 alternations per minute, and which could no doubt be speeded up, if there was any particular advantage in doing it, just as the new machine of Salomons & Pike could be speeded up to still higher frequency.

I have built a machine capable of giving over 2,000,000 alternations per minute, but it has become of little value to me, because, since its construction, I have devised a plan which, as yet, is not ready for publication on account of patents, whereby a continuous current is, by purely electrical processes, made to give alternating currents of any desired frequency, and a frequency which, by the most simple means, can be governed to cover almost any range. I only regret that circumstances do not allow me to publish the method, as it is an interesting one. I have used it upwards of a year ago. The apparatus has no moving parts.

Elihu Thomson, *per* J. W. G.

Thwaite's Scheme for the Transmission of E.M.F. Generated at the Coal Fields.—Mr. Thwaite's Reply.

Your leadgrette article on this subject has received my careful and appreciative consideration.

I regret that, what you consider the florid literary method of expression, does not altogether please you; but after all, isn't this question one of purely literary taste, and if it is to be discussed at all, are not the pages of, say, the *Athenæum* or those of the *Academy* more appropriate for such a literary controversy than those of a journal devoted to the review of electrical progress?

If the florid method of expression is a fault, and an *ex parte* opinion doesn't prove it to be such, it is surely a very pardonable one, just as is the embellishment of a piece of mechanical apparatus, by painting, turning and polishing, the machine may be as perfect for the work it is intended to perform, without the touch of ornate art, but very few men, except those of the rabid anti-Ruskin type, find fault with the association of the utile with the ornamental.

It may be, I do not fully admit it, that the diamonds of the Manchester Association of Engineers are not so finely cut or polished as those of the Metropolitan Engineering Societies, but do not their facets sparkle quite as brilliantly as those of the Metropolis, and are they not of quite as pure a water?

My reviewer must remember that it is from what he terms the rough diamond (Manchester and district quality) that the polishing wheel of engineering experience has given to the world, diamonds whose sparkle is yet undimmed, and whose light has added lustre to, and has extended the boundaries of engineering and physical science.

To illustrate the truth of this florid statement, one has only to refer to Arkwright, Crompton, Kay, Fairbairn, Whitworth, Adamson, Whitehead and Wilde. Of the two last named, the former introducing the torpedo, the latter its antidote, *i.e.*, the electric search light. Added to these names, and associated with the thermo-dynamic and chemical science allied to that of engineering, are the names of Dalton and Joule.

What has been written respecting the benefits to be derived by the application of science, has been written without the shadow of a perversion.

It is said that I ought to have known that the phenomenal success of the cotton manufacture in Lancashire is due to the dampness of the atmosphere. As the promoter of the first textile technical society formed in this country, I do know the

causes of the rapid, not phenomenal development of our textile manufactures, and the statement made by your reviewer is only a shadow of the truth; the solid cause is a combination of circumstances, not the least of which is the fact, that Lancashire men and rough diamonds, invented, developed and perfected the textile machinery of the cotton manufacturing industry. Your reviewer should know that it is not of *vital* importance that cotton mills or weaving sheds should be erected in damp localities. What about India (here we have a phenomenal development), Alsace-Lorraine, and the Fall River, U.S.? If your critic will refer to my work,* he will see described in its pages applied methods of ventilation by which a certain moisture can be added to the air, to enable the operations involved in cotton manufacture to be satisfactorily performed, so that it is not absolutely necessary that the cotton mills should be erected in damp atmospheric localities.

My theory relating to the dampness of Manchester and other towns mentioned, has *not* been shaken. I know these towns intimately, and I have often been struck with the fact, that whilst in the surrounding country the weather has been free from rain, on entering Manchester there has been the inevitable Manchester drizzle.

The oxidation of the hydro-carbons of the thousands upon thousands of tons of coals burnt in the boiler furnace grates in the industrial centres referred to in my paper must necessarily produce an enormous weight of water. Here is the equation in which the hydro-carbons of the coal are represented, for simplicity, by the expression of $C_2 H_4$.

The oxidation of this hydrocarbon will be $C_2 H_4 + 6 N_4 O = 2 C O_2 + 2 H_2 O + 2_4 N$. The water vapour will be noticed, *verb. sap.*

This action also proceeds in the ordinary domestic grate.

Besides, there is the addition of the steam from the high-pressure non-condensing engines, and the steam from the dye works, the print works, and the operations of textile manufacture requiring steam.

Given that the ultimate hygrometric limit of saturation equals 75 per cent., and that the natural hygrometric conditions rarely exceed 73 per cent., then the addition by the operations of man of water vapour by even 2½ per cent. would raise the percentage of moisture above the ultimate saturation point, and rain would fall, bringing down the suspended vapour in the area immediately surrounding the locale of the industrial operations that has provoked the rainfall.

By certain definite experiments I have proved that the greasy condition of the Manchester and London atmosphere is principally due to the condensed and unburnt hydro-carbons, so that any reduction in the coal consumption will have a *pari passu* influence in reducing the hygrometric or moist and greasy condition of the atmosphere.

It is quite easy to understand why Seathwaite, and even the village of Thwaite, in the Lake District, have comparatively high rainfalls, which naturally accompany lake, mountainous and woodland districts.

It is absurd to compare the hygrometic characteristics of dissimilar geographic and topographic localities. Probably the few paltry tons of water mentioned by you as being added, as incidents of our industrial operations, would swell out on careful calculation, to very many thousands of tons.

Considering the relatively small proportion of water that the air will hold in suspension as aqueous vapour, it can easily be realised that the addition, in a contracted area, of a great and continuously added weight of water must seriously influence the character of the atmosphere over the industrial area.

I am pleased to notice that you agree in the argument that the production of power can, "*ceteris paribus*, be much more economically effected by means of a large high-class generating plant, *well kept up*, than by innumerable small engines; and, further, any loss in the electrical transmission must be far outweighed by the saving in cost of fuel and labour."

The suggestion you make, that a few of the cotton mill engines should become dynamo drivers at night, is a good one, and where there is surplus power this might, and is done, in the instance of several Lancashire mills. At the Portwood Mills, Stockport, a considerable saving in cost of lighting was realised by this procedure. You infer that unless we drive every separate machine with its own electric motor, you do not quite see that *much* advantage would be derived, but *I do suggest* that *every* machine should be driven by *its own motor*. You say that it would be needful to convey some of the fuel gas from Centreville to the industrial centre, in pipes laid under or along side the electric mains. This may eventually follow the establishment of the electric energy transmission system; it would certainly fill in the gap in the picture.

At present the very small proportion of the heat required in some mills for warming, sizing, fulling, and other purposes, could be supplied on the Perkins system, and the steam boiler required would be a very small affair, compared with that for the present low pressure system. Of course, this is on the assumption that the electro-thermic appliances will not have been developed in the interim between conception and application, to serve for industrial purposes.

I do not think that you are right in suggesting that the loss of dynamo energy, by the present power transmission system of belts, pulleys, shafting, and toothed gearing, is generally recognised. To many engineers the graphic diagrams of loss accompanying my paper have been a startling surprise.

In a mill absorbing 1,000 tons of coal per week, and allowing a loss of E.M.F. equal to 10 per cent. of the initial energy at the coal field, Lancashire centre, there is still a net 20 per cent. of possible saving, by means of a complete system of electric power transmission; this means a saving of 200 tons per week, or 10,000 tons a year.

The paragraph in your review relating to the loss of dynamic energy by its reconversion by friction into heat is interesting, but to set up an argument in its favour on economic grounds is, with all due deference, absurd. I think you recognise this. The added torsional effect due to friction, and also the methods of diverting the direction of power, absorb a great part of the 30 per cent. loss, part of which is also reconverted into heat by the friction of the bearings, but that the heat, thus produced, is sufficient to warm the factory appreciably, and with a shadow of efficiency, I directly *contest*, in fact, I should be much surprised if in one hour of running the temperature of the air in the factory increased by half a degree Centigrade; whereas a few hundredweights of coal burnt per hour, and economically transformed into high-pressure steam, would raise the temperature of the air to the desired degree.

This question of steam heating, although a comparatively *minor* element of heat consumption compared with that required for generating power, is raised up to the level of an important objection; a simple calculation would be adequate to prove its shadowy character, which would disappear as soon as properly looked upon. Moreover, this objection is one of a varying character, tailing down in summer to a negligible quantity, and in winter attaining its maximum.

We can therefore dismiss this factor, with the concession that out of the 200 tons saved per week by electric transmission, say 20 tons might be deducted to provide high-pressure steam for warming purposes.

The electrical H.P. cost, = 0·65d., is the factor of cost of power *delivered in London, not in Lancashire or Yorkshire*. A reference to the graphic diagrams accompanying my paper, will show that the cost of power at the mills will be less than even the present rate.

The saving may be approximated, thus, and accepting your figures as the basis of computation.

Because the plant at Centreville will work day and *night*, all the year round, then the interest on capital will be reduced thus— $\frac{2\frac{1}{2} \times 10}{24} = 1{\cdot}04$d. per H.P. per week.

Then the relative cost of the present system and that of proposed electric one stands thus:—

COST OF H.P. PER WEEK.

Present System.		*Proposed Electric System.*	
Coal	3d.	Coal (Gas engines)	1·5d.
Labour ...	1d.	Labour	0·5d.
Interest on capital	2·5d.	Interest	1·04d.
	6·5d.		3·04d

* "Our Factories and Workshops; their sanitary and fire-resisting arrangements, 1882." B. H. Thwaite, C.E. London: E. & F. N. Spon.

Add to the electric system figure = 10 per cent. for loss of efficiency, and 10 per cent. for additional interest on total capital expenditure—

Then $$\frac{3{\cdot}04}{10} = 0{\cdot}304 \times 2 = 0{\cdot}6048$$

and $$3{\cdot}04 + 0{\cdot}608 = 3{\cdot}648.$$

But if the additional efficiency 25 per cent. in complete energy transmission is realised, then

$$3{\cdot}648 - \left(\frac{3{\cdot}648 \times 25}{100}\right) = 2{\cdot}736$$

or the cost of an electric horse-power per week will be 2·73d.

Against this may be put the cost of steam warming the mills and for generating the other proportion of steam required for industrial operations, and if we add 10 per cent. to the cost for this, then it comes to exactly 3d. per E.H.P. per week against 6½d., the cost of the present system, and accepting your own figures.

Your stated consumption of fuel per horse-power is, I think, below the average, which would probably be nearer to 3 lbs. than 2¼ lbs. Although in the more modern high class steam mill engines an efficiency equivalent to 1·56 lbs. of coal per I.H.P has been registered ; * but to replace the present steam practice plant, with high-class Corliss, Sulzer-Brown or Proell engines, would probably involve the clearing out of 90 out of every 100 mill engines in Lancashire and Yorkshire.

And this, in the face of the very probable carrying out of the electrical distribution of power schemes, will never occur.

The thermic loss in the generation of motor fuel gas is shown in the graphic diagrams accompanying my paper ; the loss of heat by radiation from side of generator vessels can be reduced to a negligible quantity, and by means of the annular condenser system the sensible heat of the generator gas is recovered.

The possibility of the general use of the actinic energy of the arc light is more probable than you appear to imagine, and, on the authority of Dr. F. W. Oliver, of Kew Gardens, I may say that it has been sufficiently established that the growth of plants can be appreciably accelerated by the judicious use of the electric light, and it only remains for the horticultural capitalists to try the system on an extensive scale. A line of gardens, farm and horticultural, laid and cultivated along, or near to, the lines of transmission, would eventually follow the establishment of the system proposed. It has been conclusively proved that the actinic effect of the voltaic arc assists most strikingly the germination of peas, beans, barley, &c. Besides, I have demonstrated, beyond cavil, its remarkable influence on floral and plant life.

The arguments you advance in favour of railway coal conveyance *v.* electric transmission of energy, are, I think, untenable.

Where do you get your figure 30 lbs. of coal per mile for goods traffic ? Hadn't you better multiply this by at least 2, or, to represent the average cost in fuel, by 3 ? This would then, I think, give a more nearly accurate representation of cost.

You forget, also, that the same or another locomotive engine has to return over the entire length with empty coal trucks. You also overlook the enormous cost of remedying the wear and tear.

The rate of 0·83d. per mile per ton imposed on the Great Western Railway when they obtained original powers does not, I believe, pay them, and they have in the more recent extensions insisted on the usual rate—1½d. per ton per mile I believe, being charged. I am inclined to think that the maintenance of a high-class passenger permanent way, due to the great wear by coal-carrying rolling stock, and the miserable solid bumper character of this latter stock, *costs more than is returned as profit by the coal-carrying traffic.* Then there are all the costs of supervision, and the almost innumerable other items of cost associated with railway coal-carrying traffic. Whereas the *simple copper electric energy transmission conductor* in a hundred years hence will probably be *worth more* than it would the day it was *established.* On the other hand, the rails and rolling stock even the expensive locomotives—which latter are, moreover comparatively low in thermo-dynamic efficiency—may have *had to be entirely renewed* several times in the *same period.* Besides, the railway companies are at this very moment increasing the goods rates to a very serious extent.

I think, after perusing these arguments, you will readily concede that the verdict is on the side of electric transmission of the thermic energy.

Your remarks, *re* oil insulation, are witty enough, and the reference to an incident in Sir Walter Scott's life, anent the lost button, is laughably pertinent ; and as you submit without much protest to the oil insulator part of the project, nothing further need be said.

I am inclined to dispute the assertion that it only costs $\frac{1}{10}$d. per horse-power in London for larger power quantities, and should like to know the authority for this statement. As it is admitted that the small power engines cost 50 times this, or 5d. per H.P. per hour, the proposed charge of 0·65d. in London would be an excellent *bargain for the consumer.*

The reference to the short-sighted lines of English railway mismanagement is timely, but it is proved, *nem. con.*, that 0·83d. per ton per mile is not a satisfactory return for this kind of traffic. It is hardly likely, therefore, that any drastic alteration will be made to meet the coming rivalry of electric transmission of energy. I think, on the contrary, the railway companies will welcome a slight relief from the congestion of the traffic, especially as the bulk of the railway carried coal is required for *domestic consumption*, and the weight of coal displaced by the electric transmission project would not appreciably interfere with their traffic.

I am glad that the financial arguments in favour of the copper conductor are accepted as good and sound. This fact of solid copper, being an absolutely safe investment, is one of the most important *prima facie* advantages of long distance electric transmission, and will have more weight with one class of investor, than any other argument. It practically, by equivalence, reduces the first cost by one-third, enabling, as it does, the acquirement of capital at very low and government-stock rate of interest.

I am glad that you accept the principle of the scheme fractionally, at least, and hope, on consideration, that you will go further, and accept it *en bloc.* Whilst agreeing with you, that a modification of the scheme, or the establishment of extramural generating stations, would be better than the present system, the following unrivalled advantages may be claimed for the coal field *locale* :—

Land sufficient for building the electric 10,000 B.H.P. generating station may be purchased probably for £200 ; this area, near London, might cost £10,000, or even £15,000.

The collieries could be supplied with the E.M.F., and a profit could be obtained from this source.

Pure water supply can be obtained for a mere fraction. Labour is far less costly, and less difficult to control, in an isolated place. The labour would be more efficient and regular. There would be no heavy rates to pay.

No local interference by trades unions or municipalities. These advantages are so obvious, that there is no necessity to further dilate on them.

You will notice that only a 300 B.H.P. gas engine is proposed, and this size is not an experiment. It is better, seeing the high thermo-dynamic efficiencies of this gas engine of 100 to 300 B.H.P., to imitate the gas works system, where many retort benches are employed, and are put to work as the demand arises. Then 300 B.H.P. engines can be automatically thrown out of action as the demand falls off ; the gas generated would then flow into the large storage holders, so that the E.M.F. generating station at Centreville would have all the practical advantages of a gas works station, without requiring a single storage battery.

Your hope "that the scheme advocated will become thoroughly and completely practicable, in the sense of being financially applicable to concerns of 1,000 H.P., and to supply heat for trade purposes as well as of power," is encouraging.

New departures and projects are never born without the pains and struggling incidents of birth.

A well-born or well thought out and rational scheme will sooner or later force its way into recognition, to be followed by actual accomplishment. May the day *not* be far distant when the projects outlined become fulfilled, is, I think, the hope of most patriots and progressivist engineers.

B. H. Thwaite.

January 2nd, 1893.

* *Vide* p. 27, "Mill Engines": A Lecture. B. H. Thwaite. Goodall and Suddick, Leeds.